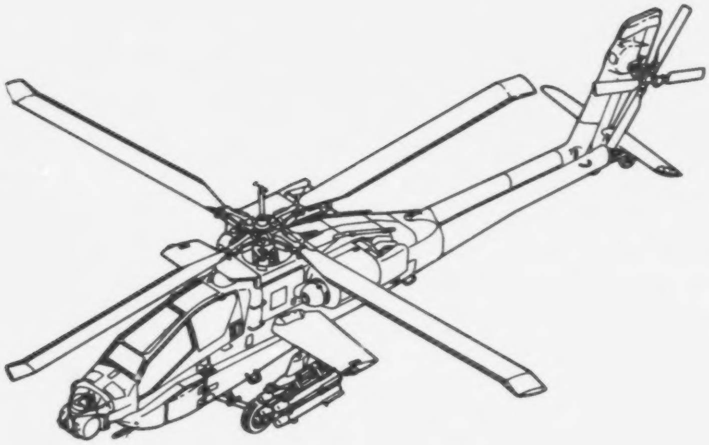
55-1520-238-10/990

TM 55-1520-238-10

WARNING DATA
TABLE OF CONTENTS
INTRODUCTION
DESCRIPTION AND OPERATION
AVIONICS
MISSION EQUIPMENT
OPERATING LIMITS AND RESTRICTIONS
WEIGHT/BALANCE AND LOADING
PERFORMANCE DATA
NORMAL PROCEDURES
EMERGENCY PROCEDURES
REFERENCES
ABBREVIATIONS AND TERMS
ALPHABETICAL INDEX

TECHNICAL MANUAL

OPERATOR'S MANUAL
FOR
ARMY AH-64A HELICOPTER



HEADQUARTERS, DEPARTMENT OF THE ARMY
28 JUNE 1984

This copy is a reprint which includes current pages from Changes 1 through 15.

D101.11:

READEX FICHE best copy available

URGENT

NOTE: THIS CHANGE HAS BEEN PRINTED AND DISTRIBUTED OUT OF SEQUENCE. IT SHOULD BE INSERTED IN THE MANUAL AND USED. UPON RECEIPT OF THE EARLIER SEQUENCED CHANGE, ENSURE A MORE CURRENT CHANGE PAGE IS NOT REPLACED WITH A LESS CURRENT PAGE.

CHANGE }
NO. 15 }

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D.C., 18 MAY 1989

Operator's Manual
for
ARMY AH-64A HELICOPTER

TM 55-1520-238-10, 28 June 1984, is changed as follows:

1. Remove and insert pages as indicated below. New or changed text material is indicated by a vertical bar in the margin. An illustration change is indicated by a miniature pointing hand.

Remove pages	Insert pages
5-11 and 5-12	5-11 and 5-12

2. Retain this sheet in front of manual for reference purposes.

By Order of the Secretary of the Army:

CARL E. VUONO
General, United States Army
Chief of Staff

Official:

WILLIAM J. MEEHAN II
Brigadier General, United States Army
The Adjutant General

DISTRIBUTION:
To be distributed in accordance with DA Form 12-31, -10 & CL Maintenance requirements for AH-64A Helicopter, Attack (APACHE).

URGENT

CHANGE
NO. 14

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D. C., 12 July 1989

Operator's Manual
for
ARMY AH-64A HELICOPTER

TM 55-1520-238-10, 28 June 1984, is changed as follows:

1. Remove and insert pages as indicated below. New or changed text material is indicated by a vertical bar in the margin. An illustration change is indicated by a miniature pointing hand.

Remove pages	Insert pages
WARNING-1 and WARNING-2	WARNING-1 and WARNING-2
A and B	A and B
- - -	C/D
1-1 and 1-2	1-1 and 1-2
2-1 through 2-4	2-1 through 2-4
2-9 through 2-14	2-9 through 2-14
2-17 through 2-20	2-17 through 2-20
- - -	2-20.1 and 2-20.2
2-21 through 2-24	2-21 through 2-24
- - -	2-24.1 and 2-24.2
2-25 through 2-36	2-25 through 2-36
2-43 and 2-44	2-43 and 2-44
2-49 and 2-50	2-49 and 2-50
2-51 and 2-52	2-51 and 2-52
2-52.1/2-52.2	2-52.1/2-52.2
2-55 through 2-70	2-55 through 2-70
2-73 through 2-84	2-73 through 2-84
2-87 through 2-90	2-87 through 2-90
3-1 through 3-4	3-1 through 3-4
- - -	3-4.1/3-4.2
3-5 and 3-6	3-5 and 3-6
3-6A/3-6B	3-6.1/3-6.2
3-7 through 3-10	3-7 through 3-10
- - -	3-10.1 and 3-10.2
3-11 through 3-14	3-11 through 3-14
- - -	3-14.1 and 3-14.2
3-15 and 3-16	3-15 and 3-16
3-16.1/3-16.2	3-16.1/3-16.2
3-17 and 3-18	3-17 and 3-18
3-25 and 3-26	3-25 and 3-26
3-26.1 through 3-26.16	3-26.1 through 3-26.16

Remove pages	Insert pages
3-27 through 3-34	3-27 through 3-34
4-1 and 4-2	4-1 and 4-2
4-5 and 4-6	4-5 and 4-6
4-11 through 4-14	4-11 through 4-14
4-17 through 4-24	4-17 through 4-24
4-34.1 and 4-34.2	4-34.1 and 4-34.2
4-35 through 4-38	4-35 through 4-38
4-38.1/4-38.2	4-38.1/4-38.2
4-39 and 4-40	4-39 and 4-40
4-40.1/4-40.2	4-40.1/4-40.2
4-41 and 4-42	4-41 and 4-42
4-43 and 4-44	4-43 and 4-44
4-47 and 4-48	4-47 and 4-48
4-51 and 4-52	4-51 and 4-52
- - -	4-52.1 through 4-52.3/4-52.4
4-53 through 4-58	4-53 through 4-58
5-5 through 5-10	5-5 through 5-10
6-1 through 6-6	6-1 through 6-6
6-11 through 6-20	6-11 through 6-20
7-11 and 7-12	7-11 and 7-12
7-15 and 7-16	7-15 and 7-16
7-19 and 7-20	7-19 and 7-20
- - -	7-72.1/7-72.2
7-73 and 7-74	7-73 and 7-74
7-77 and 7-78	7-77 and 7-78
8-5 and 8-6	8-5 and 8-6
8-9 through 8-19/8-20	8-9 through 8-20
9-1 and 9-2	9-1 and 9-2
- - -	9-2.1/9-2.2
9-3 through 9-10	9-3 through 9-10
9-10.1/9-10.2	9-10.1 and 9-10.2
9-11 through 9-17/9-18	9-11 through 9-17/9-18
A-1/A-2	A-1 and A-2
B-1 through B-6	B-1 through B-6
B-9 and B-10	B-9 and B-10
Index-1 through Index -14	Index-1 through Index-13/ Index-14

2. Retain this sheet in front of manual for reference purposes.

By Order of the Secretary of the Army:

CARL E. VUONO
General, United States Army
Chief of Staff

Official:

WILLIAM J. MEEHAN II
Brigadier General, United States Army
The Adjutant General

DISTRIBUTION:
To be distributed in accordance with DA Form 12-31, -10 and CL Maintenance requirements for AH-64A Helicopter, Attack (APACHE).

URGENT

CHANGE }
NO. 13 }

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D.C., 26 September 1988

Operator's Manual
for
ARMY AH-64A HELICOPTER

TM 55-1520-238-10, 28 June 1984, is changed as follows:

1. Remove and insert pages as indicated below. New or changed text material is indicated by a vertical bar in the margin. An illustration change is indicated by a miniature pointing hand.

Remove pages	Insert pages
9-3 and 9-4	9-3 and 9-4
9-11 and 9-12	9-11 and 9-12

2. Retain this sheet in front of manual for reference purposes.

By Order of the Secretary of the Army:

CARL E. VUONO
General, United States Army
Chief of Staff

Official:

R. L. DILWORTH
Brigadier General, United States Army
The Adjutant General

DISTRIBUTION:
To be distributed in accordance with DA Form 12-31, -10 and CL Maintenance requirements for AH-64A Helicopter, Attack (APACHE).

URGENT

URGENT

TM 55-1520-238-10
C 12

CHANGE
NO. 12

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D.C., 2 SEPTEMBER 1988

Operator's Manual
for
ARMY AH-64A HELICOPTER

TM 55-1520-238-10, 28 June 1984, is changed as follows:

1. Remove and insert pages as indicated below. New or changed text material is indicated by a vertical bar in the margin. An illustration change is indicated by a minature pointing hand.

Remove pages	Insert pages
---	3-16.1/(3-16.2 blank)
3-17 and 3-18	3-17 and 3-18
---	3-26.1 through 3-26.16

2. Retain this sheet in front of manual for reference purposes.

By Order of the Secretary of the Army:

CARL E. VUONO
General, United States Army
Chief of Staff

Official:

R. L. DILWORTH
Brigadier General, United States Army
The Adjutant General

DISTRIBUTION:
To be distributed in accordance with DA Form 12-31, -10 & CL Maintenance requirements for AH-64A Helicopter, Attach (APACHE).

URGENT

URGENT

TM 55-1520-238-10
C 11

CHANGE
NO. 11

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D.C., 15 April 1988

Operator's Manual
for
ARMY AH-64A HELICOPTER

TM 55-1520-238-10, 28 June 1984, is changed as follows:

1. Remove and insert pages as indicated below. New or changed text material is indicated by a vertical bar in the margin. An illustration change is indicated by a miniature pointing hand.

Remove pages	Insert pages
2-73 and 2-74	2-73 and 2-74
2-77 and 2-78	2-77 and 2-78
4-17 through 4-20	4-17 through 4-20
8-9 through 8-14	8-9 through 8-14
9-15 through 9-17/9-18	9-15 through 9-17/9-18

2. Retain this sheet in front of manual for reference purposes.

By Order of the Secretary of the Army:

CARL E. VUONO
General, United States Army
Chief of Staff

Official:

R. L. DILWORTH
Brigadier General, United States Army
The Adjutant General

DISTRIBUTION:
To be distributed in accordance with DA Form 12-31, -10 and CL Maintenance requirements for AH-64A Helicopter, Attack (APACHE).

URGENT

URGENT

TM 55-1520-238-10
C 10

CHANGE
NO. 10

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D.C., 15 October 1987

Operator's Manual
for
ARMY AH-64A HELICOPTER

TM 55-1520-238-10, 28 June 1984, is changed as follows:

1. Remove and insert pages as indicated below. New or changed text material is indicated by a vertical bar in the margin. An illustration change is indicated by a miniature pointing hand.

Remove pages	Insert pages
- - -	4-10.1/4-10.2
9-5 through 9-10	9-5 through 9-10
- - -	9-10.1/9-10.2
9-11 and 9-12	9-11 and 9-12
9-17/9-18	9-17/9-18

2. Retain this sheet in front of manual for reference purposes.

By Order of the Secretary of the Army:

CARL E. VUONO
General, United States Army
Chief of Staff

Official:

R. L. DILWORTH
Brigadier General, United States Army
The Adjutant General

DISTRIBUTION:
To be distributed in accordance with DA Form 12-31, -10 and CL Maintenance requirements for AH-64A Helicopter, Attack (APACHE).

URGENT

URGENT

NOTICE: THIS CHANGE HAS BEEN PRINTED AND DISTRIBUTED OUT OF SEQUENCE. IT SHOULD BE INSERTED IN THE MANUAL AND USED. UPON RECEIPT OF THE EARLIER SEQUENCED CHANGE INSURE A MORE CURRENT CHANGE PAGE IS NOT REPLACED WITH A LESS CURRENT PAGE.

TM 55-1520-238-10
C 9

CHANGE }
NO. 9 }

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D.C., 27 May 1987

Operator's Manual
for
ARMY AH-64A HELICOPTER

TM 55-1520-238-10, 28 June 1984, is changed as follows:

1. Remove and insert pages as indicated below. New or changed text material is indicated by a vertical bar in the margin. An illustration change is indicated by a miniature pointing hand.

Remove pages	Insert pages
4-35 and 4-36	4-35 and 4-36
---	4-36.1/4-36.2
4-37 and 4-38	4-37 and 4-38
---	4-38.1/4-38.2
4-39 and 4-40	4-39 and 4-40
---	4-40.1/4-40.2
4-41 and 4-42	4-41 and 4-42
---	4-42.1/4-42.2

2. Retain this sheet in front of manual for reference purposes.

By Order of the Secretary of the Army:

JOHN A. WICKHAM, JR.
General, United States Army
Chief of Staff

Official:

R. L. DILWORTH
Brigadier General, United States Army
The Adjutant General

DISTRIBUTION:
To be distributed in accordance with DA Form 12-31, -10 and CL Maintenance requirements for AH-64A Helicopter, Attack (APACHE).

URGENT

CHANGE
NO. 8

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D.C., 18 May 1987

Operator's Manual
for
ARMY AH-64A HELICOPTER

TM 55-1520-238-10, 28 June 1984, is changed as follows:

1. Remove and insert pages as indicated below. New or changed text material is indicated by a vertical bar in the margin. An illustration change is indicated by a miniature pointing hand.

Remove pages	Insert pages
A and B	A and B
2-9 and 2-10	2-9 and 2-10
2-19 and 2-20	2-19 and 2-20
2-25 through 2-38	2-25 through 2-38
2-41 and 2-42	2-41 and 2-42
2-42A/2-42B	2-42.1/2-42.2
2-43 through 2-48	2-43 through 2-48
2-51 and 2-52	2-51 and 2-52
2-52A/2-52B	2-52.1/2-52.2
2-63 through 2-66	2-63 through 2-66
2-69 through 2-72	2-69 through 2-72
2-77 and 2-78	2-77 and 2-78
2-85 and 2-86	2-85 and 2-86
2-87 through 2-90	2-87 through 2-90
3-5 and 3-6	3-5 and 3-6
3-9 through 3-12	3-9 through 3-12
3-25 through 3-32	3-25 through 3-32
4-3 and 4-4	4-3 and 4-4
4-11 and 4-12	4-11 and 4-12
4-19 through 4-28	4-19 through 4-28
4-28A/4-28B	4-28.1/4-28.2
4-29 and 4-30	4-29 and 4-30
4-33 and 4-34	4-33 and 4-34
4-34A and 4-34B	4-34.1 and 4-34.2
4-43 through 4-46	4-43 through 4-46
4-51 through 4-59/4-60	4-51 through 4-60
---	4-61/4-62
5-1 and 5-2	5-1 and 5-2
5-5 and 5-6	5-5 and 5-6
5-9 through 5-14	5-9 through 5-13/5-14
6 3 through 6-21/6-22	6-3 through 6-21/6-22
7-3 and 7-4	7-3 and 7-4
7-11 and 7-12	7-11 and 7-12
---	7-12.1/7-12.2
7-13 through 7-18	7-13 through 7-18
---	7-72.1/7-72.2
7-73 and 7-74	7-73 and 7-74

Remove pages	Insert pages
7-79 and 7-80	7-79 and 7-80
8-1 through 8-18	8-1 through 8-18
8-19 and 8-20	8-19/8-20
9-3 through 9-6	9-3 through 9-6
9-13 through 9-17/9-18	9-13 through 9-17/9-18
A-1/A-2	A-1/A-2
Index 1 through Index 20	Index 1 through Index 20

2. Retain this sheet in front of manual for reference purposes.

By Order of the Secretary of the Army:

CARL E. VUONO
General, United States Army
Chief of Staff

Official:

R. L. DILWORTH
Brigadier General, United States Army
The Adjutant General

DISTRIBUTION:
To be distributed in accordance with DA Form 12-31, -10 and CL requirements for AH-64A Helicopter, Attack (APACHE).

NOTICE: THIS CHANGE HAS BEEN PRINTED AND DISTRIBUTED OUT OF SEQUENCE. IT SHOULD BE INSERTED IN THE MANUAL AND USED. UPON RECEIPT OF THE EARLIER SEQUENCED CHANGE INSURE A MORE CURRENT CHANGE PAGE IS NOT REPLACED WITH A LESS CURRENT PAGE.

URGENT

TM 55-1520-238-10
C 7

CHANGE
NO. 7

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D.C., 11 March 1987

Operator's Manual
for
ARMY AH-64A HELICOPTER

TM 55-1520-238-10, 28 June 1984, is changed as follows:

1. Remove and insert pages as indicated below. New or changed text material is indicated by a vertical bar in the margin. An illustration change is indicated by a miniature pointing hand.

Remove pages	Insert pages
8-9 and 8-10	8-9 and 8-10
8-11 and 8-12	8-11 and 8-12

2. Retain this sheet in front of manual for reference purposes.

By Order of the Secretary of the Army:

JOHN A. WICKHAM, JR.
General, United States Army
Chief of Staff

Official:

R. L. DILWORTH
Brigadier General, United States Army
The Adjutant General

DISTRIBUTION:
To be distributed in accordance with DA Form 12-31, -10 and CL Maintenance requirements for AH-64A Helicopter, Attack (APACHE).

URGENT

URGENT

NOTICE: THIS CHANGE HAS BEEN PRINTED AND DISTRIBUTED OUT OF SEQUENCE. IT SHOULD BE INSERTED IN THE MANUAL AND USED. UPON RECEIPT OF THE EARLIER SEQUENCED CHANGE INSURE A MORE CURRENT CHANGE PAGE IS NOT REPLACED WITH A LESS CURRENT PAGE.

TM 55-1520-238-10
C 6

CHANGE }
NO. 6 }

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D.C., 15 October 1986

Operator's Manual for ARMY AH-64A HELICOPTER

TM 55-1520-238-10, 28 June 1984, is changed as follows:

1. Remove and isnert pages as indicated below. New or changed text material is indicated by a vertical bar in the margin. An illustration change is indicated by a miniature pointing hand.

Remove pages	Insert pages
6-1 and 6-2	6-1 and 6-2

2. Retain this sheet in front of manual for reference purposes.

By Order of the Secretary of the Army:

JOHN A. WICKHAM, JR.
General, United States Army
Chief of Staff

Official:

R. L. DILWORTH
Brigadier General, United States Army
The Adjutant General

DISTRIBUTION:
To be distributed in accordance with DA Form 12-31, -10 and CL Maintenance requirements for AH-64A Helicopter, Attack (APACHE).

URGENT

URGENT

NOTICE: THIS CHANGE HAS BEEN PRINTED AND DISTRIBUTED OUT OF SEQUENCE. IT SHOULD BE INSERTED IN THE MANUAL AND USED. UPON RECEIPT OF THE EARLIER SEQUENCED CHANGE INSURE A MORE CURRENT CHANGE PAGE IS NOT REPLACED WITH A LESS CURRENT PAGE.

TM 55-1520-238-10
C 5

CHANGE
NO. 5

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D.C., 10 September 1986

Operator's Manual
for
ARMY AH-64A HELICOPTER

TM 55-1520-238-10, 28 June 1984, is changed as follows:

1. Remove and insert pages as indicated below. New or changed text material is indicated by a vertical bar in the margin. An illustration change is indicated by a miniature pointing hand.

Remove pages	Insert pages
8-19 and 8-20	8-19 and 8-20

2. Retain this sheet in front of manual for reference purposes.

By Order of the Secretary of the Army:

JOHN A. WICKHAM, JR.
General, United States Army
Chief of Staff

Official:

R. L. DILWORTH
Brigadier General, United States Army
The Adjutant General

DISTRIBUTION:
To be distributed in accordance with DA Form 12-31, -10 & CL Maintenance requirements for AH-64A Helicopter, Attack, (APACHE).

URGENT

CHANGE
NO. 4

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D.C., 15 August 1986

Operator's Manual
for
ARMY AH-64A HELICOPTER

TM 55-1520-238-10, 28 June 1984, is changed as follows:

1. Remove and insert pages as indicated below. New or changed text material is indicated by a vertical bar in the margin. An illustration change is indicated by a miniature pointing hand.

Remove pages	Insert pages
A and B	A and B
2-9 through 2-14	2-9 through 2-14
2-29 through 2-32	2-29 through 2-32
2-35 and 2-36	2-35 and 2-36
2-55 and 2-56	2-55 and 2-56
2-61 and 2-62	2-61 and 2-62
8-11 through 8-14	8-11 through 8-14
8-21 through 8-26	- - -

2. Retain this sheet in front of manual for reference purposes.

By Order of the Secretary of the Army:

JOHN A. WICKHAM, JR.
General, United States Army
Chief of Staff

Official:

R. L. DILWORTH
Brigadier General, United States Army
The Adjutant General

DISTRIBUTION:
To be distributed in accordance with DA Form 12-31, -10 & CL Maintenance requirements for AH-64A Helicopter, Attack (APACHE).

URGENT

TM 55-1520-238-10
C 3

CHANGE
NO. 3

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D.C., 24 July 1986

Operator's Manual
for
ARMY AH-64A HELICOPTER

TM 55-1520-238-10, 28 June 1984, is changed as follows:

1. Remove and insert pages as indicated below. New or changed text material is indicated by a vertical bar in the margin. An illustration change is indicated by a miniature pointing hand.

Remove pages	Insert pages
2-27 and 2-28	2-27 and 2-28
8-15 and 8-16	8-15 and 8-16
9-9 and 9-10	9-9 and 9-10

2. Retain these sheets in front of manual for reference purposes.

By Order of the Secretary of the Army:

JOHN A. WICKHAM, JR.
General, United States Army
Chief of Staff

Official:

R. L. DILWORTH
Brigadier General, United States Army
The Adjutant General

DISTRIBUTION:
To be distributed in accordance with DA Form 12-31, -10 and CL requirements for AH-64A Helicopter, Attack (APACHE).

This publication is a courtesy quick copy from the UNITED STATES ARMY PUBLICATIONS CENTER, ST. LOUIS, MISSOURI, to meet your needs while we are replenishing our regular stock.

URGENT

TM 55-1520-238-10
C 2

CHANGE }
NO. 2 }

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D.C., 5 May 1986

Operator's Manual
for
ARMY AH-64A HELICOPTER

TM 55-1520-238-10, 28 June 1984, is changed as follows:

1. Remove and insert pages as indicated below. New or changed text material is indicated by a vertical bar in the margin. An illustration change is indicated by a miniature pointing hand.

Remove pages	Insert pages
- - -	A and B
Warning 1 and Warning 2	Warning 1 and Warning 2
i and ii	i and ii
1-1 and 1-2	1-1 and 1-2
2-1 through 2-4	2-1 through 2-4
2-7 through 2-12	2-7 through 2-12
2-15 through 2-18	2-15 through 2-18
2-23 through 2-32	2-23 through 2-32
2-35 and 2-36	2-35 and 2-36
2-39 through 2-42	2-39 through 2-42
- - -	2-42A/2-42B
2-43 and 2-44	2-43 and 2-44
2-51 through 2-54	2-51 through 2-54
2-57 and 2-58	2-57 and 2-58
2-63 through 2-86	2-63 through 2-86
- - -	2-86A/2-86B
2-87 through 2-90	2-87 through 2-90
3-3 through 3-6	3-3 through 3-6
3-6A/3-6B	3-6A/3-6B
3-21 and 3-22	3-21 and 3-22
3-27 and 3-28	3-27 and 3-28
3-31 through 3-34	3-31 through 3-34
4-3 through 4-6	4-3 through 4-6
4-9 through 4-14	4-9 through 4-14
4-19 through 4-28	4-19 through 4-28
4-28A/4-28B	4-28A/4-28B
4-29 through 4-32	4-29 through 4-32
4-34A/4-34B	4-34A and 4-34B
4-35 through 4-42	4-35 through 4-42
4-49 through 4-58	4-49 through 4-58
5-5 through 5-10	5-5 through 5-10
6-1 and 6-2	6-1 and 6-2
6-5 and 6-6	6-5 and 6-6
7-9 through 7-12	7-9 through 7-12
8-1 through 8-20	8-1 through 8-20
9-1 through 9-16	9-1 through 9-16
9-17/9-18	9-17/9-18
Index 1 through Index 20	Index 1 through Index 20

2. Retain these sheets in front of manual for reference purposes.

By Order of the Secretary of the Army:

JOHN A. WICKHAM, JR.
General, United States Army
Chief of Staff

Official:

R. L. DILWORTH
Brigadier General, United States Army
The Adjutant General

DISTRIBUTION:
To be distributed in accordance with DA Form 12-31, -10 & CL Maintenance requirements for AH-64A Helicopter, Attack (APACHE).

CHANGE }
No. 1 }

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D.C., 3 May 1985

Operator's Manual
for
ARMY AH-64A HELICOPTER

TM 55-1520-238-10, 28 June 1984, is changed as follows:

1. Remove and insert pages as indicated below. New or changed text material is indicated by a vertical bar in the margin. An illustration change is indicated by a miniature pointing hand.

Remove pages	Insert pages
Warning 1 and Warning 2	Warning 1 and Warning 2
i and ii	i and ii
1-1 and 1-2	1-2 and 1-2
2-1 through 2-32	2-1 through 2-32
2-37 through 2-52	2-37 through 2-52
- - -	2-52A/2-52B
2-53 through 2-60	2-53 through 2-60
2-63 through 2-80	2-63 through 2-80
2-87 through 2-90	2-87 through 2-90
3-1 and 3-2	3-1 and 3-2
3-5 and 3-6	3-5 and 3-6
- - -	3-6A/3-6B
3-9 and 3-10	3-9 and 3-10
3-17 through 3-22	3-17 through 3-22
3-25 and 3-26	3-25 and 3-26
3-31 through 3-33/3-34	3-31 through 3-35/3-36
4-1 through 4-10	4-1 through 4-10
- - -	4-10A/4-10B
4-11 through 4-14	4-11 through 4-14
4-19 through 4-22	4-19 through 4-22
4-25 through 4-28	4-25 through 4-28
- - -	4-28A/4-28B
4-29 through 4-34	4-29 through 4-34
- - -	4-34A/4-34B
4-35 and 4-36	4-35 and 4-36
4-39 through 4-48	4-39 through 4-48
4-51 through 4-59/4-60	4-51 through 4-59/4-60
5-1 through 5-4	5-1 through 5-4
5-9 through 5-12	5-9 through 5-12
6-7 and 6-8	6-7 and 6-8
7-11 and 7-12	7-11 and 7-12
7-15 and 7-16	7-15 and 7-16
7-19 and 7-20	7-19 and 7-20
8-1 through 8-25/8-26	8-1 through 8-26
9-1 through 9-17/9-18	9-1 through 9-17/9-18
Index 1 through Index 16	Index 1 through Index 16

2. Retain these sheets in front of manual for reference purposes.

By Order of the Secretary of the Army:

JOHN A. WICKHAM, JR.
General, United States Army
Chief of Staff

Official:

DONALD J. DELANDRO
Brigadier General, United States Army
The Adjutant General

DISTRIBUTION:
To be distributed in accordance with DA Form 12-31, Operator's Maintenance requirements for AH-64A aircraft.

INSERT LATEST CHANGED PAGES: DESTROY SUPERSEDED PAGES.

LIST OF EFFECTIVE PAGES

NOTE: The portion of the text affected by the changes is indicated by a vertical line in the outer margins of the page. Changes to illustrations are indicated by miniature pointing hands. Changes to wiring diagrams are indicated by shaded areas.

Dates of issue for original and changed pages are:

Original	0	28 Jun 1984	Change	7	11 Mar 1987
Change	1	3 May 1985	Change	8	18 May 1987
Change	2	5 May 1986	Change	9	27 May 1987
Change	3	24 Jul 1986	Change	10	15 Oct 1987
Change	4	15 Aug 1986	Change	11	15 Apr 1988
Change	5	10 Sep 1986	Change	12	2 Sep 1988
Change	6	15 Oct 1986	Change	13	26 Sep 1988
			Change	14	

TOTAL NUMBER OF PAGES IN THIS PUBLICATIONS IS 418, CONSISTING OF THE FOLLOWING:

Page No.	*Change No.	Page No.	*Change No.
Title	0	2-43	14
A-C/(D blank)	14	2-44 - 2-45	1
Warning 1	14	2-46 - 2-47	8
Warning 2	2	2-48	1
i	2	2-49	14
ii	2	2-50 - 2-51	1
1-1	0	2-52	14
1-2	14	2-52.1/(2-52.2 blank)	14
2-1	14	2-53	2
2-2	2	2-54	1
2-3 - 2-4	14	2-55 - 2-59	14
2-5 - 2-6	1	2-60	0
2-7	2	2-61 - 2-65	14
2-8	1	2-66 - 2-67	2
2-9 - 2-10	14	2-68	14
2-11	4	2-69	0
2-12 - 2-13	14	2-70	14
2-14 - 2-15	1	2-71	8
2-16 - 2-17	2	2-72	1
2-18	14	2-73 - 2-75	14
2-19	0	2-76	2
2-20	14	2-77 - 2-81	14
2-20.1 - 2-20.2	14	2-82	0
2-21	14	2-83 - 2-84	14
2-22	0	2-85	8
2-23 - 2-24	14	2-86	2
2-24.1 - 2-24.2	14	2-86A/(2-86B blank)	2
2-25 - 2-26	14	2-87	14
2-27	1	2-88	8
2-28 - 2-32	14	2-89 - 2-90	14
2-33	8	3-1	14
2-34 - 2-35	14	3-2 - 3-3	0
2-36	0	3-4	14
2-37	1	3-4.1/(3-4.2 blank)	14
2-38	8	3-5 - 3-6	14
2-39	2	3-6.1/(3-6.2 blank)	14
2-40 - 2-41	1	3-7	0
2-42	8	3-8	14
2-42.1/(2-42.2 blank)	8	3-9	1
		3-10	14

*Zero in this column indicates an original page.

INSERT LATEST CHANGED PAGES: DESTROY SUPERSEDED PAGES.

LIST OF EFFECTIVE PAGES

Page No.	*Change No.
3-10.1 - 3-10.2	14
3-11	8
3-12 - 3-14	14
3-14.1 - 3-14.2	14
3-15	0
3-16	14
3-16.1/(3-16.2 blank)	14
3-17	12
3-18	14
3-19	1
3-20	0
3-21	2
3-22	1
3-23 - 3-24	0
3-25	1
3-26	14
3-26.1 - 3-26.16	14
3-27 - 3-29	14
3-30	8
3-31	14
3-32	1
3-33 - 3-34	14
3-35/(3-36 blank)	1
4-1	14
4-2	0
4-3	8
4-4	2
4-5	14
4-6 - 4-9	1
4-10	2
4-10.1/(4-10.2 blank)	10
4-11 - 4-13	14
4-14	2
4-15 - 4-17	0
4-18 - 4-19	14
4-20	8
4-21	14
4-22	8
4-23 - 4-24	14
4-25	8
4-26 - 4-27	2
4-28	8
4-28.1/(4-28.2 blank)	8
4-29	8

Page No.	*Change No.
4-30 - 4-31	2
4-32	0
4-33	8
4-34	1
4-34.1 - 4-34.2	14
4-35 - 4-36	14
4-36.1/(4-36.2 blank)	9
4-37	14
4-38	9
4-38.1/(4-38.2 blank)	14
4-39	14
4-40	9
4-40.1/(4-40.2 blank)	14
4-41 - 4-42	14
4-42.1/(4-42.2 blank)	9
4-43	14
4-44 - 4-46	8
4-47	14
4-48	0
4-49	2
4-50	0
4-51 - 4-52	14
4-52.1 - 4-52.2	14
4-52.3/(4-52.4 blank)	14
4-53 - 4-58	14
4-59 - 4-60	8
4-61/(4-62 blank)	14
5-1 - 5-2	8
5-3	0
5-4	1
5-5	14
5-6	0
5-7	14
5-8	2
5-9 - 5-10	14
5-11	8
5-12	14
5-13/(5-14 blank)	8
6-1 - 6-6	14
6-7 - 6-10	Deleted
6-11 - 6-18	14
6-19	8
6-20	14
6-21/(6-22 blank)	8
7-1 - 7-3	0

*Zero in this column indicates an original page.

LIST OF EFFECTIVE PAGES

INSERT LATEST CHANGED PAGES: DESTROY SUPERSEDED PAGES.

Page No.	*Change No.
7-4	8
7-5 - 7-10	0
7-11 - 7-12	14
7-12.1/(7-12.2 blank)	8
7-13 - 7-15	8
7-16	14
7-17	8
7-18	0
7-19	14
7-20 - 7-72	0
7-72.1/(7-72.2 blank)	14
7-73	14
7-74	8
7-75 - 7-77	0
7-78	14
7-79 - 7-80	Deleted
8-1 - 8-2	8
8-3	0
8-4	8
8-5 - 8-6	14
8-7 - 8-8	8
8-9 - 8-14	14
8-15	8
8-16 - 8-17	14
8-18	8
8-19 - 8-20	14
9-1 - 9-2	14
9-2.1/(9-2.2 blank)	14
9-3	14
9-4 - 9-5	2
9-6 - 9-7	14
9-8	1
9-9 - 9-10	14
9-10.1 - 9-10.2	14
9-11 - 9-16	14
9-17/(9-18 blank)	14
A-1 - A-2	14
B-1	0
B-2	14
B-3	0
B-4 - B-6	14
B-7 - B-8	0
B-9	14
B-10	0
Index-1 - Index-12	14
Index-13/(Index-14 blank)	14

*Zero in this column indicates an original page.

TABLE OF CONTENTS

REPORTING OF ERRORS

Every effort is made to keep this publication current and error-free. Review conferences with using personnel and a constant review of accident and flight test reports ensure inclusion of the latest data in the publication. However, we cannot correct an error unless we know of it. In this regard, it is essential you do your part. Reports of errors, omissions and recommendations for improving this publication by you is encouraged. Your letter or DA Form 2028 (Recommended Changes to Publications and Blank Forms), or DA Form 2028-2 (Test) (Recommended Changes to Equipment Technical Manuals) located in the back of this manual, should be mailed to Commander, USAAVSCOM, Attn: AMSAV-MPSD, 4300 Goodfellow Blvd, St. Louis, Mo. 63120-1798. A reply will be furnished directly to you.

		Page
CHAPTER 1	**INTRODUCTION**	1-1
CHAPTER 2	**AIRCRAFT AND SYSTEMS DESCRIPTION AND OPERATION**	2-1
Section I	Aircraft	2-1
Section II	Emergency Equipment	2-18
Section III	Engines and Related Systems	2-21
Section IV	Fuel System	2-32
Section V	Flight Controls and Automatic Stabilization Equipment	2-39
Section VI	Hydraulic and Pressurized Air Systems	2-44
Section VII	Power Train	2-50
Section VIII	Main and Tail Rotor Groups	2-53
Section IX	Utility Systems	2-54
Section X	Heating and Ventilation	2-57
Section XI	Electrical Power Supply and Distribution System	2-59
Section XII	Auxiliary Power Unit (APU)	2-64
Section XIII	Lighting	2-67
Section XIV	Flight Instruments	2-69
Section XV	Servicing, Parking, Mooring	2-80
CHAPTER 3	**AVIONICS**	3-1
Section I	General	3-1
Section II	Communications	3-5
Section III	Navigation	3-15
CHAPTER 4	**MISSION EQUIPMENT**	4-1
Section I	Mission Avionics	4-1
Section II	Armament	4-47

		Page
CHAPTER 5	**OPERATING LIMITS AND RESTRICTIONS**	5-1
Section I	General	5-1
Section II	System Limits	5-2
Section III	Power Limits	5-9
Section IV	Loading Limits	5-10
Section V	Airspeed Limits	5-10
Section VI	Maneuvering Limits	5-12
Section VII	Environmental Restrictions	5-12
Section VIII	Other Limits	5-12
CHAPTER 6	**WEIGHT/BALANCE AND LOADING**	6-1
Section I	General	6-1
Section II	Weight and Balance	6-3
Section III	Fuel and Oil	6-10
Section IV	Personnel	6-13
Section V	Mission Equipment	6-14
Section VI	Cargo Loading	6-18
Section VII	Allowable Loading	6-19
CHAPTER 7	**PERFORMANCE DATA**	7-1
Section I	Introduction	7-1
Section II	Maximum Torque Available - 30-Minute Limit	7-8
Section III	Hover Ceiling	7-10
Section IV	Hover	7-12
Section V	Takeoff	7-14
Section VI	Cruise	7-16
Section VII	Drag	7-72
Section VIII	Climb-Descent	7-74
Section IX	Climb Performance	7-76
Section X	Idle Fuel Flow	7-79
CHAPTER 8	**NORMAL PROCEDURES**	8-1
Section I	Mission Planning	8-1
Section II	Operating Procedures and Maneuvers	8-2
Section III	Instrument Flight	8-16
Section IV	Flight Characteristics	8-16
Section V	Adverse Environmental Conditions	8-17
Section VI	Crew Duties	8-20
CHAPTER 9	**EMERGENCY PROCEDURES**	9-1
Section I	Helicopter Systems	9-1
Section II	Mission Equipment	9-14
Section III	Caution/Warning Light Emergency Procedures	9-15
APPENDIX A	**REFERENCES**	A-1
APPENDIX B	**ABBREVIATIONS AND TERMS**	B-1
INDEX	**INDEX**	INDEX-1

WARNING

Personnel performing operations, procedures, and practices which are included or implied in this technical manual shall observe the following warnings. Disregard of these warnings and precautionary information can cause serious injury or loss of life.

AVIATION LIFE SUPPORT EQUIPMENT

Aviation life support equipment shall be utilized in accordance with AR 95-1, FM 1-302, and AR 95-3. Failure to do so may result in personal injury or loss of life.

BATTERY ELECTROLYTE

Battery electrolyte is harmful to the skin and clothing. Neutralize any spilled electrolyte by thoroughly flushing contacted area with water.

CANOPY JETTISON

Canopy jettison safety pins shall be installed in pilot, copilot/gunner, and external firing mechanisms when the helicopter is on the ground. Pilot and copilot/gunner safety pins shall be removed before starting engines. Safety pins shall be installed during engine shutdown check. Debris may be expelled 50 feet outward when system is actuated. Pilot and copilot/gunner helmet visor should be down to prevent eye injury.

CARBON MONOXIDE

When smoke, suspected carbon monoxide fumes, or symptoms of anoxia exist, the crew should immediately ventilate the cockpit.

ELECTROMAGNETIC INTERFERENCE (EMI)

No electrical/electronic devices of any sort, other than those described in this manual or appropriate maintenance manuals, are to be operated by crew members during operation of this helicopter. Flights near high power radio transmitters' high intensity radio transmission areas (HIRTA) may cause degraded system operation.

FIRE EXTINGUISHER

Exposure to high concentrations of extinguishing agent, or decomposition products, should be avoided. The liquid should not be allowed to contact the skin; it may cause frostbite or low-temperature burns.

GROUND OPERATION

Engines will be started and operated only by authorized personnel. Reference AR 95-1 and AR 95-13.

HANDLING FUEL, OIL, AND HYDRAULIC FLUIDS

Turbine and lubricating oils contain additives which are poisonous and readily absorbed through the skin. Do not allow them to remain on skin longer than necessary. Prolonged contact may cause a skin rash. Prolonged contact with hydraulic fluid will cause burns. Refer to TM 10-1101 and FM 1068 when handling fuel.

HIGH VOLTAGE

All ground handling personnel must be informed of high voltage hazards when working near Target Acquisition Designator Sight (TADS) and Pilot Night Vision Sensor (PNVS) equipment.

LASER LIGHT

The laser light beam is dangerous and can cause blindness if it enters the eye either directly or reflected from a surface. Personnel shall wear approved laser protection whenever in a controlled area when laser rangefinder or laser target designators are being used. Laser shall be used only in controlled areas by qualified personnel.

NOISE

Sound pressure levels around helicopters during some operating conditions exceed the Surgeon General's hearing conservation criteria as defined in TB MED 251. Hearing protection devices, such as the aviator helmet or ear plugs, are required to be worn by all personnel in and around the helicopter during its operation.

STARTING ENGINES AND AUXILIARY POWER UNIT

Be sure that the rotor and blast area is clear, and a fire guard is posted if available.

VERTIGO

The anti-collision strobe lights should be off during flight through clouds to prevent sensations of vertigo as a result of reflections of the light on the clouds.

WEAPONS AND AMMUNITION

Observe all standard safety precautions governing the handling of weapons and live ammunition. When not in use, point all weapons in a direction away from personnel and property in case of accidental firing. Do not walk in front of weapons. SAFE all weapons before servicing. To avoid potentially dangerous situations, follow all procedural warnings in this text.

WING STORES JETTISON

All jettison safety pins shall be installed when the helicopter is on the ground. Safety pins shall be removed prior to flight. Failure to do so will prevent jettison of wing stores.

CHAPTER 1

INTRODUCTION

1-1. GENERAL.

These instructions are for use of the operators. Instructions apply to AH-64A helicopters.

1-2. Warnings, Cautions, and Notes Defined.

Warnings, Cautions, and Notes are used to emphasize important and critical instruction for the following conditions:

WARNING

An operating procedure, practice, etc., which if not correctly followed, could result in personal injury or loss of life.

CAUTION

An operating procedure, practice, etc., which if not correctly followed, could result in damage to or destruction of equipment.

NOTE

An operating procedure, condition, etc., which is essential to highlight.

1-3. DESCRIPTION.

This manual contains the best operating instructions and procedures for the AH-64A helicopter under most circumstances. The helicopter is capable of carrying two crew members: a pilot and a copilot/gunner (CPG). The helicopter is designed as a weapons-delivery platform and is equipped with point target (Hellfire missile), area weapon (30mm chain gun), and aerial rocket (2.75-inch folding-fin type) systems. The observance of limitations, performance, and weight and balance data provided in this manual is mandatory. The observance of procedures is also mandatory, except when modification is required because of multiple emergencies, adverse weather, terrain, etc. Basic flight principles are not included. **THIS MANUAL SHALL BE CARRIED IN THE HELICOPTER AT ALL TIMES.**

1-4. Appendix A, References.

Appendix A is a listing of official publications cited within the manual and is applicable to, and available for, flight crews.

1-5. Appendix B, Abbreviations and Terms.

Appendix B is a list of abbreviations to be used to clarify the text in this manual only. They are not necessarily standard abbreviations.

1-6. Index.

The Index lists, in alphabetical order, every titled paragraph, figure, and table contained in this manual. Chapter 7, Performance Data, has an additional index within the chapter.

1-7. Army Aviation Safety Program.

Reports necessary to comply with the safety program are prescribed in AR 385-40.

1-8. Destruction of Army Materiel to Prevent Enemy Use.

For information concerning destruction of Army materiel to prevent enemy use refer to TM 750-244-1-5.

1-9. Forms and Records.

Army aviator's flight record and aircraft maintenance records, which are to be used by crew members, are described in FM 1-300, DA PAM 738-751 and TM 55-1500-342-23.

1-10. Explanation of Change Symbols.

Changes to the text and tables, including new material on added pages, are indicated by a vertical bar in the outer margin extending close to the entire area of the material affected. Pages with emergency markings, which consist of black diagonal lines around three edges, shall have the vertical bar or change symbol placed along the outer margins between the text and diagonal lines. Change symbols show current changes only. A miniature pointing hand symbol is used to denote a change to an illustration. However, a vertical line in the outer margin, rather than miniature pointing hands, is utilized when there have been extensive changes made to an illustration. Change symbols are not used to indicate:

a. Introductory material.

b. Indexes and tabular data where the change cannot be identified.

c. Blank space resulting from the deletion of text, an illustration, or a table.

d. Correction of minor inaccuracies, such as spelling, punctuation, relocation of material, etc., unless such correction changes the meaning of instructive information and procedures.

1-11. Aircraft Designation.

The designation system prescribed by AR 70-50 is used in aircraft designations.

1-12. Use of Shall, Will, Should, and May.

Within this technical manual, the word **shall** is used to indicate a mandatory requirement. The word **will** is used to express a declaration of purpose. The word **should** is used to indicate a non-mandatory but preferred method of accomplishment. The word **may** is used to indicate an acceptable method of accomplishment.

CHAPTER 2

AIRCRAFT AND SYSTEMS DESCRIPTION AND OPERATION

Section I. AIRCRAFT

2-1. GENERAL.

The AH-64A helicopter is a twin engine, tandem seat, aerial weapons platform.

a. **Fuselage.** The fuselage includes a forward, center, and aft section that employ aluminum alloy semimonoque construction. All major weight items (crew, fuel, and ammunition) are supported by bulkheads, frames, and a longitudinal support structure. The forward fuselage contains the copilot/gunner (CPG) station. There are also provisions for mounting the target acquisition and designation sight (TADS), pilot night vision sensor (PNVS), and a 30mm area weapon. The center section contains the pilot crew station and provides support for the oleo-damped main landing gear, main transmission, wings, fuel cells, and ammunition bay. The aft section includes the vertical stabilizer and has provisions for mounting the tail landing gear. The avionics bay and stowage compartments are contained in the aft section. The tail rotor, driveshafts, gearboxes, and stabilator are attached to the aft section.

b. **Wings.** Left and right wings are attached to the center fuselage. They are of aluminum cantilever, spar, and rib construction. Each wing provides two hardpoints for external stores and hydraulic and electrical quick-disconnects.

c. **Rotors.** The helicopter has a fully articulated four-blade main rotor system equipped with elastomeric lead-lag dampers. The tail rotor is a semi-rigid design and consists of four blades.

d. **Engines.** The helicopter is powered by two horizontally-mounted turbo-shaft engines. Power is supplied to the main transmission through engine-mounted nose gearboxes, shafts, and overrunning clutches. The main transmission drives the main and tail rotors and accessory gearbox.

e. **Special Mission Kits.** The helicopter can be equipped with an IR jammer kit, radar jammer kit, radar warning kit, winterization kit, chaff kit, and extended range kit. Refer to the applicable system for descriptive information.

2-2. Controls.

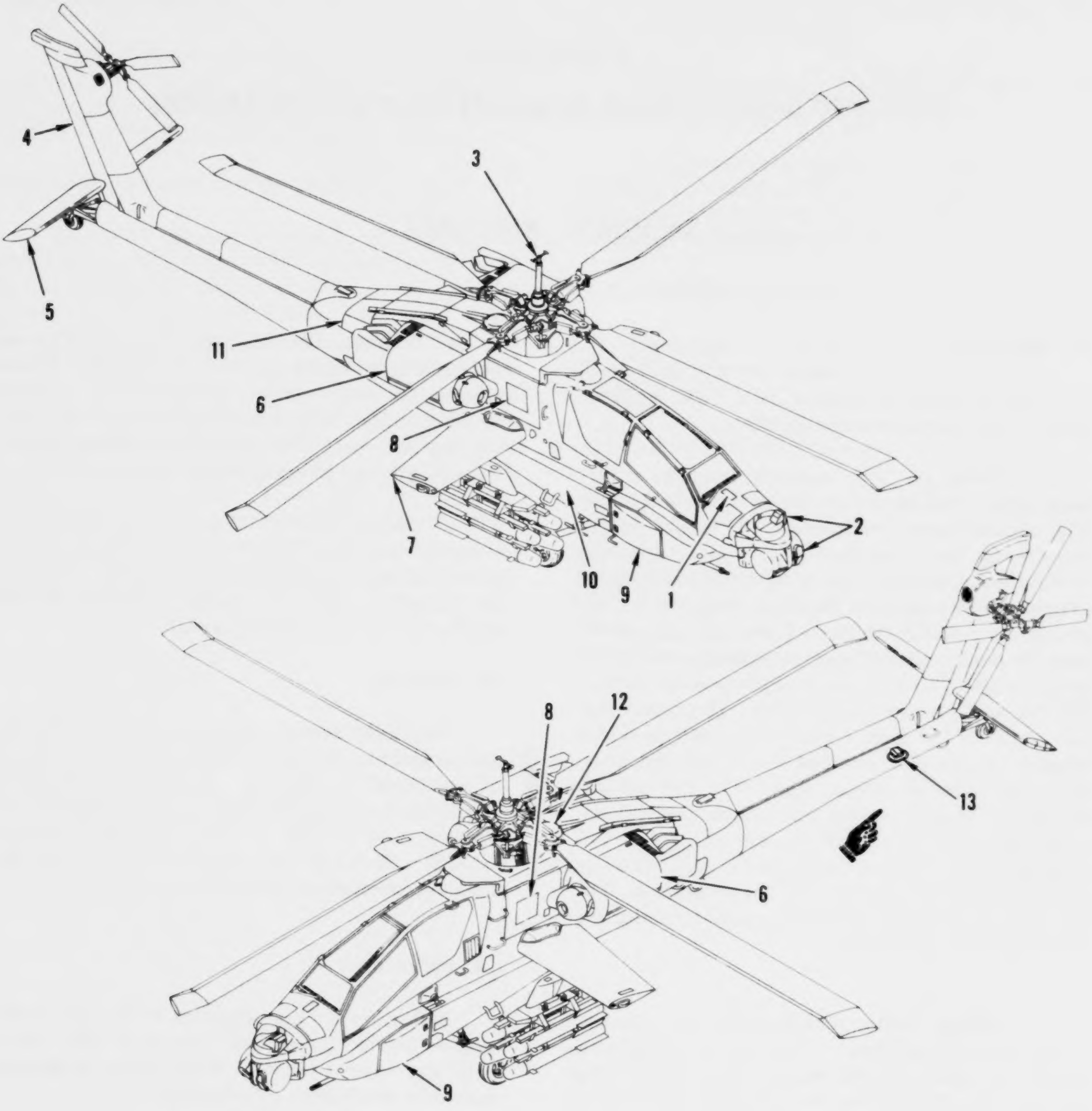
The flight control system consists of hydromechanical controls for the main and tail rotors and an electrical stabilator. A digital automatic stabilization system (DASE) is used to augment the controls, and provide a back up control system (BUCS). Refer to the applicable system for complete descriptive information.

2-3. Indicators.

Indicators for management of the helicopter systems are located on both pilot and CPG instrument and control panels. Refer to the applicable system for descriptive information.

2-4. GENERAL ARRANGEMENT.

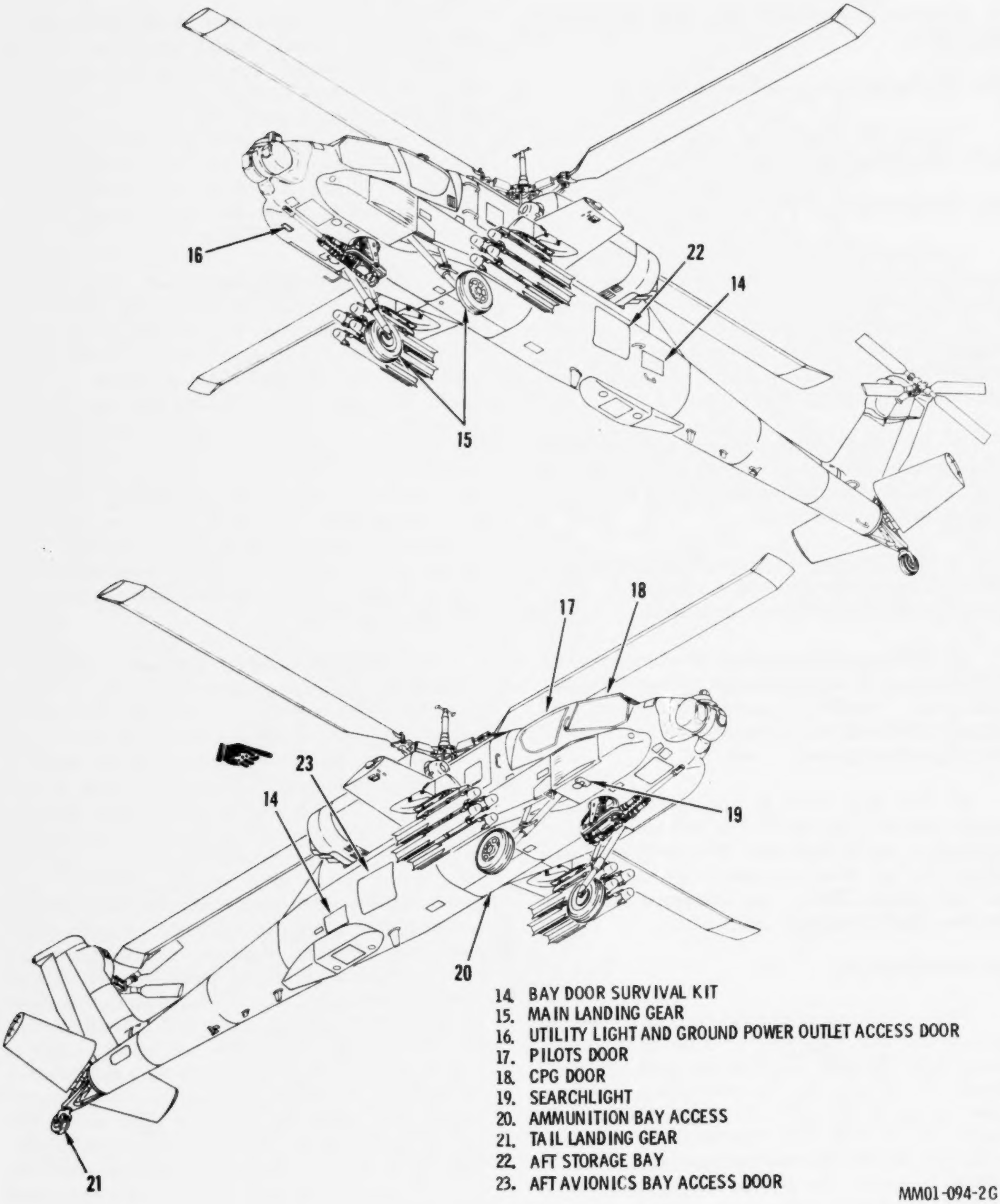
Figure 2-1 illustrates the general arrangement including accessing and some major exterior components.



1. CANOPY JETTISON HANDLE ACCESS DOOR
2. TADS AND PNVS TURRETS
3. AIR DATA SENSOR
4. VERTICAL STABILIZER
5. STABILATOR
6. NACELLE DOOR ASSEMBLY
7. INTERCOMMUNICATIONS ACCESS DOOR
8. TRANSMISSION ACCESS DOOR
9. FORWARD AVIONICS BAY ACCESS DOOR
10. FIRE EXTINGUISHER ACCESS DOOR
11. HYDRAULIC GROUND SERVICE PANEL ACCESS DOOR
12. INFRA RED COUNTER MEASURE DEVICE MOUNT
13. CHAFF PAYLOAD MODULE

MM01-094-1J

Figure 2-1. General Arrangement (Sheet 1 of 2)


16
22
14
15
18
17
23
14
19
20
21
MM01-094-2G

14. BAY DOOR SURVIVAL KIT
15. MAIN LANDING GEAR
16. UTILITY LIGHT AND GROUND POWER OUTLET ACCESS DOOR
17. PILOTS DOOR
18. CPG DOOR
19. SEARCHLIGHT
20. AMMUNITION BAY ACCESS
21. TAIL LANDING GEAR
22. AFT STORAGE BAY
23. AFT AVIONICS BAY ACCESS DOOR

Figure 2-1. General Arrangement (Sheet 2 of 2)

2-5. Principal Dimensions.

Figure 2-2 illustrates principal helicopter dimensions.

2-6. Turning Radius and Ground Clearance.

Figure 2-3 illustrates helicopter turning radius and ground clearance.

2-7. Danger Areas.

a. The shaded areas shown in figure 2-4 can be hazardous. Personnel approaching an operating helicopter must do so at a 45-degree angle from the front. The approach must be made from well outside the rotor disc area until recognition is received from the pilot. The pilot will then signal when closer approach is safe.

b. Air flow from the tail rotor and downwash from the main rotor are dangerous, even outside the turning radius of the helicopter when it is in hover or operating at takeoff power.

c. Exhaust gases from the helicopter engines and auxiliary power unit can cause burns. Personnel should remain clear of these areas.

d. During canopy-jettison, acrylic fragments will be propelled approximately 50 feet from the helicopter. Personnel approaching a crash-damaged helicopter must look for a signal from the crew that closer approach is safe.

e. The laser must be given special safety considerations because of the extreme danger involved during its operation. Relatively low laser light levels can cause permanent damage to eyes and skin burns. There is an additional danger of electrical shock from laser components.

2-8. Compartments.

The crew compartments are arranged in tandem and are separated by a ballistic shield (figure 2-5). The pilot sits aft of the copilot/gunner. Handholds and steps permit both crew members to enter and exit at the right side of the helicopter. A canopy covers both crew stations. The canopy frame and the transparent ballistic shield form a rollover structure. To provide for maximum survival and minimum vulnerability, armored seats are installed in both crew compartments.

2-9. Landing Gear.

The main landing gear (figure 2-1) supports the helicopter during ground operation (taxiing, take-off, and towing). The landing gear system is a three-point system consisting of the main landing gear, tail landing gear, and main landing gear brake system. The landing gear system provides for ease of maneuvering when taxiing and towing, has shock struts to absorb normal and high impact landings, and kneels to facilitate transport of the helicopter.

a. **Main Landing Gear**. Each main landing gear support consists of a trailing arm and a nitrogen/oil shock strut. The trailing arms transfer the helicopter landing and static loads to the airframe, and the shock struts absorb vertical loads. The upper ends of the left and right trailing arms attach to a cross tube which passes through the fuselage and is supported by fuselage-anchored pivot bearings. The upper ends of the shock struts are attached to mounts on the fuselage structure. In addition to its normal energy-absorbing function, each shock strut has a one-time high impact absorbing feature: shear rings are sheared and a rupture disc bursts causing a controlled collapse of the strut.

b. **Tail Landing Gear**. The tail landing gear consists of two trailing arms, nitrogen/oil shock strut, fork, axle, and wheel. The shock strut has an impact-absorbing capability similar to that of the main landing gear shock strut. The tail wheel is 360-degree free swiveling for taxiing and ground handling. The tail landing gear system incorporates a spring-loaded tail wheel lock. However, the tail landing gear is hydraulically unlocked from the pilot crew station or manually unlocked by a ground crew member using a handle attached to the actuator. The tail wheel lock system is actuated by hydraulic pressure from the utility hydraulic system. Pressure is routed to the actuator through a control valve located in the tail boom. The valve is controlled by the tail wheel switch (figure 2-6) at the pilot station. When the tail wheel switch is placed in UNLOCK position, pressure is applied to the actuator to retract the lock pin. A proximity switch will cause the advisory light above the switch to illuminate. When the tail wheel LOCK-UNLOCK switch is placed in LOCK position, the valve shuts off hydraulic pressure and opens the line to the actuator. This relieves the pressure on the lock. Spring force will then move the lock pin to

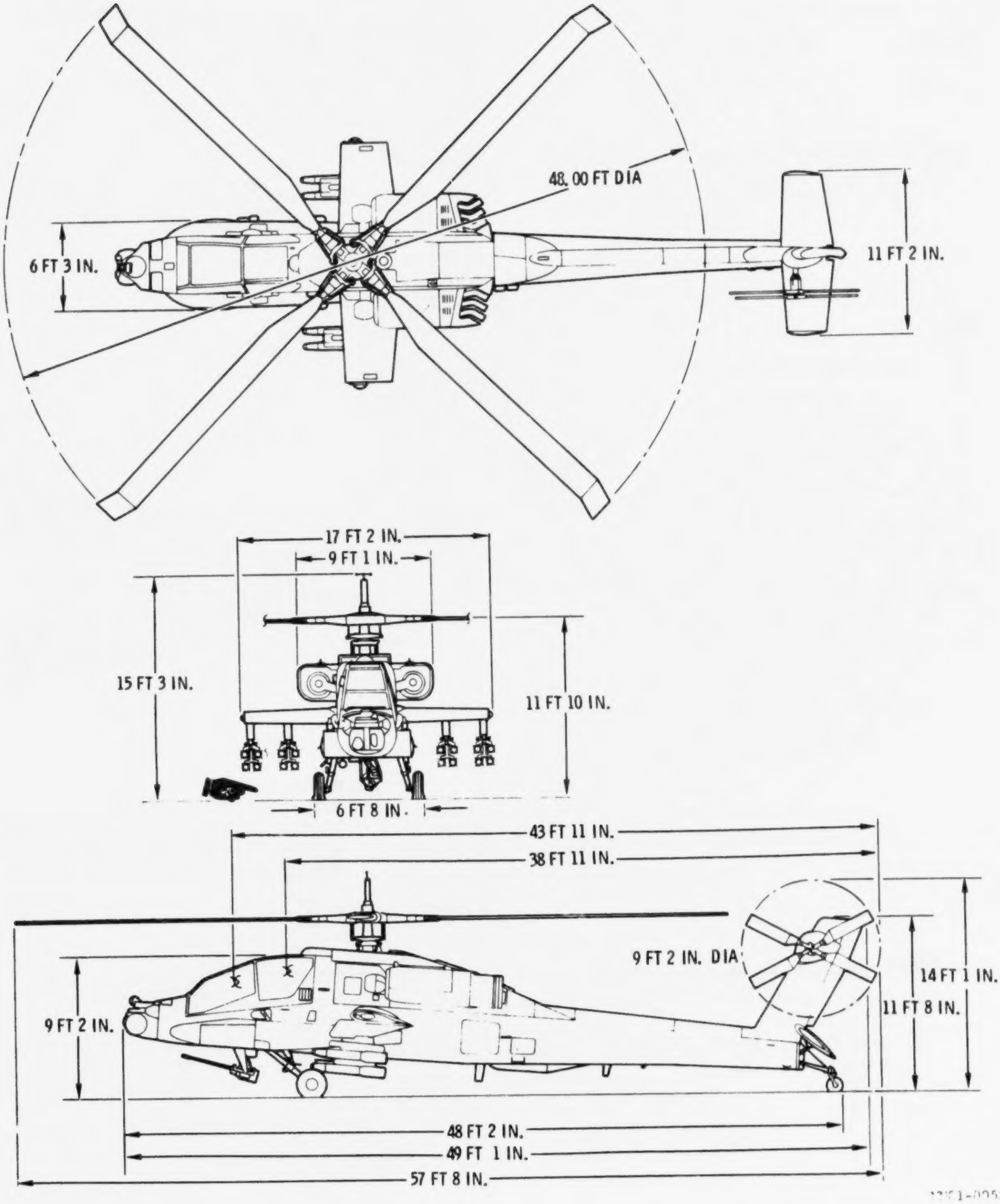

48. 00 FT DIA
6 FT 3 IN.
11 FT 2 IN.
17 FT 2 IN.
9 FT 1 IN.
15 FT 3 IN.
11 FT 10 IN.
6 FT 8 IN.
43 FT 11 IN.
38 FT 11 IN.
9 FT 2 IN. DIA
14 FT 1 IN.
11 FT 8 IN.
9 FT 2 IN.
48 FT 2 IN.
49 FT 1 IN.
57 FT 8 IN.
1201-005

Figure 2-2. Principal Helicopter Dimensions

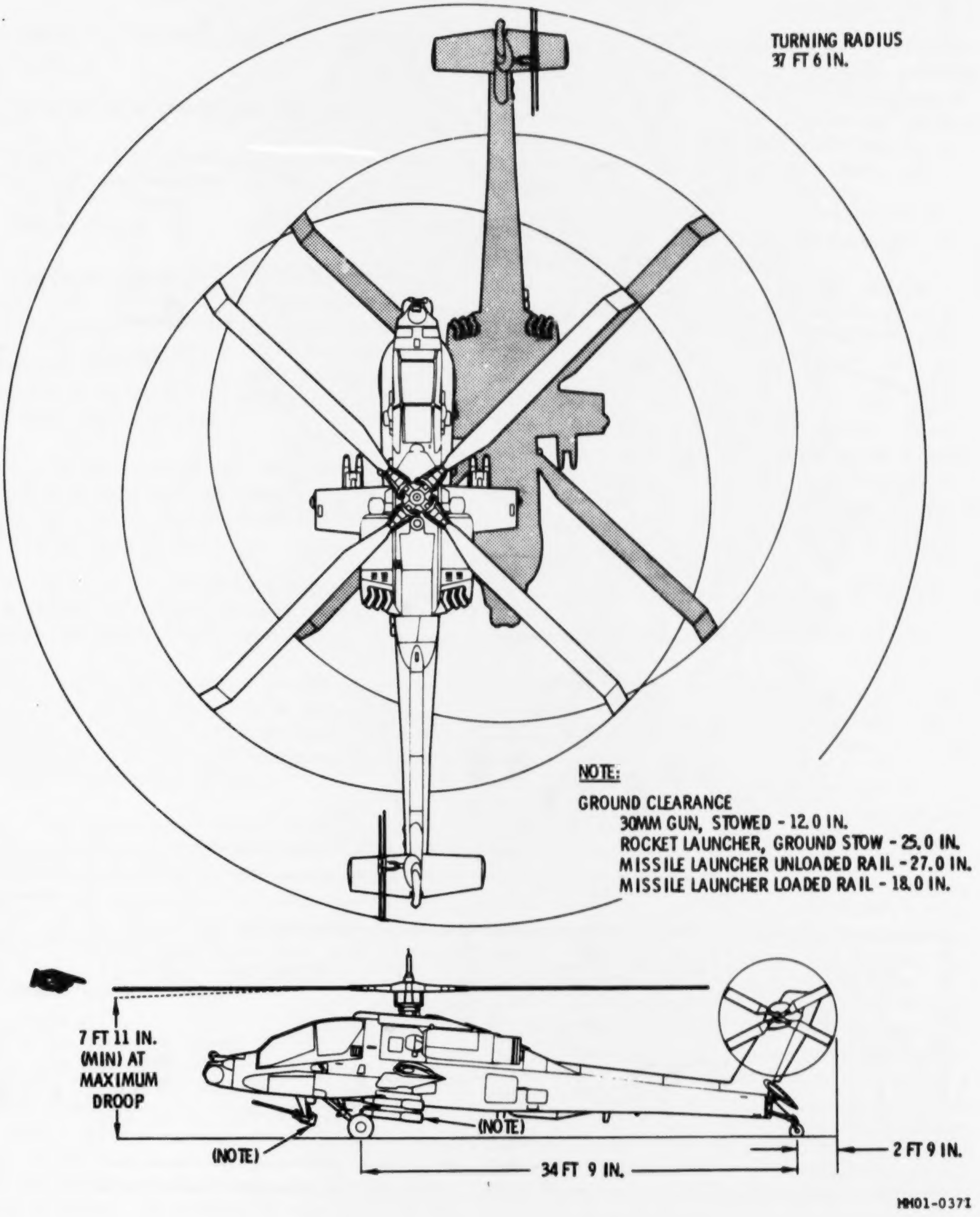
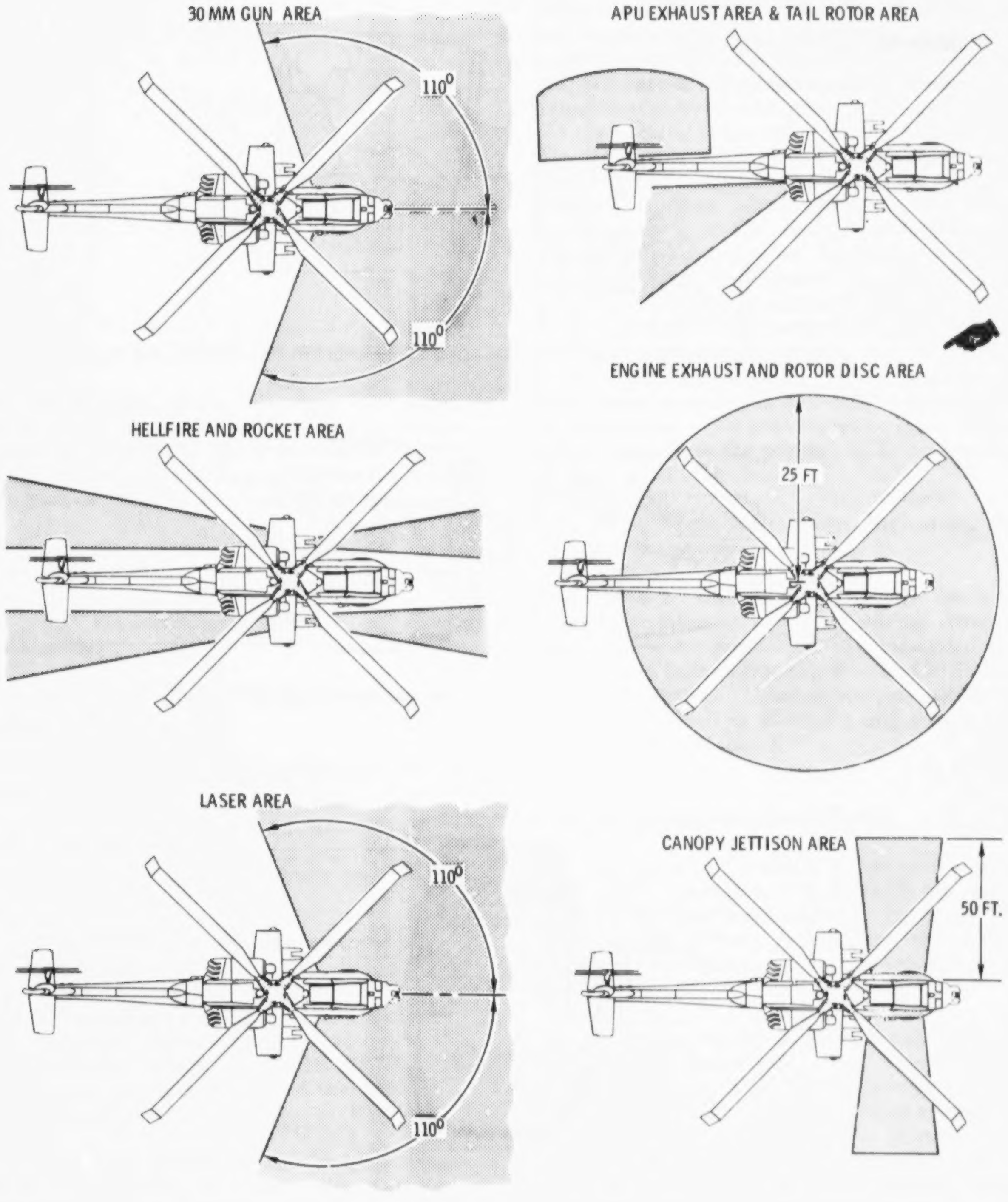
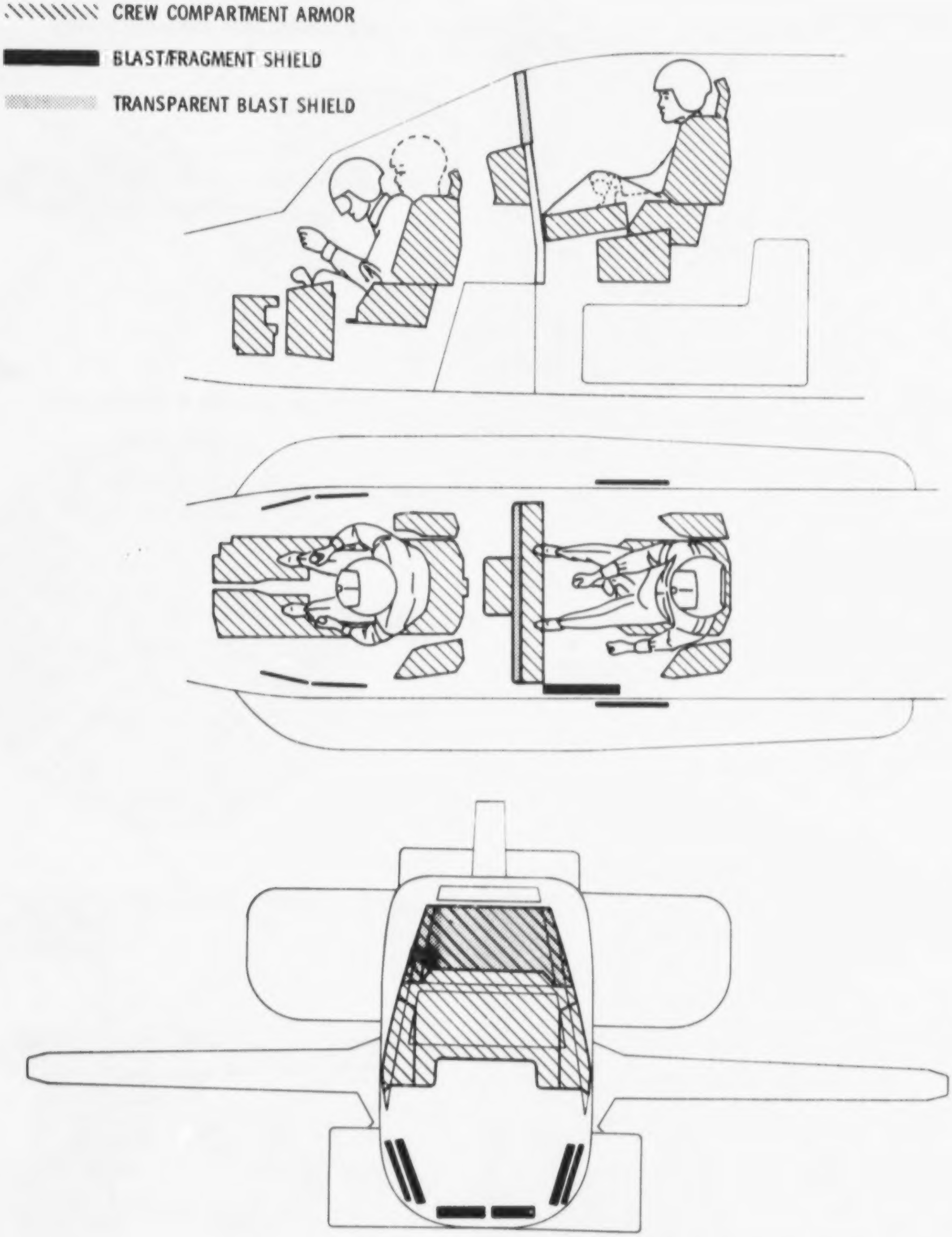

TURNING RADIUS
37 FT 6 IN.
NOTE:
GROUND CLEARANCE
30MM GUN, STOWED - 12.0 IN.
ROCKET LAUNCHER, GROUND STOW - 25.0 IN.
MISSILE LAUNCHER UNLOADED RAIL - 27.0 IN.
MISSILE LAUNCHER LOADED RAIL - 18.0 IN.
7 FT 11 IN. (MIN) AT MAXIMUM DROOP
(NOTE)
(NOTE)
34 FT 9 IN.
2 FT 9 IN.
MM01-037I

Figure 2-3. Turning Radius and Ground Clearance


30 MM GUN AREA
110°
110°
APU EXHAUST AREA & TAIL ROTOR AREA
ENGINE EXHAUST AND ROTOR DISC AREA
25 FT
HELLFIRE AND ROCKET AREA
LASER AREA
110°
110°
CANOPY JETTISON AREA
50 FT.

MM01-113E

Figure 2-4. Danger Areas


▨ CREW COMPARTMENT ARMOR
■ BLAST/FRAGMENT SHIELD
░ TRANSPARENT BLAST SHIELD

MM01-080C

Figure 2-5. Armor Protection

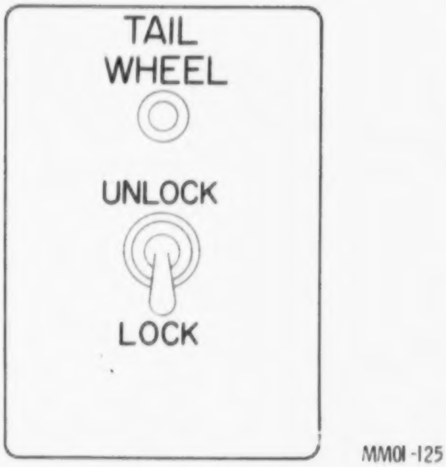


Figure 2-6. Tail Wheel Lock Panel

the lock position. If the tail wheel is unlocked manually, it can be locked from the pilot crew station by placing the tail wheel switch in UNLOCK position, then returning the switch to the lock position. The tail wheel must be locked to:

(1) Absorb rotor torque reaction during rotor brake operation.

(2) Prevent shimmy during rolling takeoffs and landings.

(3) Prevent swivel during ground operation in high winds.

(4) Prevent swivel during operation on slopes.

2-10. Landing Gear Brakes.

NOTE

It is necessary to maintain pressure on the brake until the PARK BRAKE handle is pulled out to lock the parking brakes. If the PARK BRAKE handle is pulled out without pressure applied to the brake pedals, the PARK BRAKE handle may remain out and the brakes will not be set.

The brake system affects only the main landing gear wheels. The main landing gear system consists of two independent hydromechanical systems, one left and one right. Braking action is initiated from either crew station by applying foot pressure at the top portion of the directional control pedals. This activates a master cylinder attached to each brake pedal (figures 2-7 and 2-8). The master cylinders pressurize hydraulic fluid in the master cylinder system components. This pressure is transmitted through tubing to the transfer valves, and the parking brake valve, to the wheel brake assemblies. It actuates pistons in each wheel brake assembly causing friction linings to move against a floating brake disk to stop wheel rotation. When the helicopter is parked, the pilot or CPG applies and maintains pressure on the brakes until the PARK BRAKE handle (figure 2-7) can be pulled out by the pilot to lock the parking brakes. When the brake pressure is released, the handle can be released. If the handle remains out, the parking brake should be set. Hydraulic pressure is maintained in the system by the compensator valves mounted on the parking brake valve. Either station can release the parking brake by exerting pressure on the control pedals.

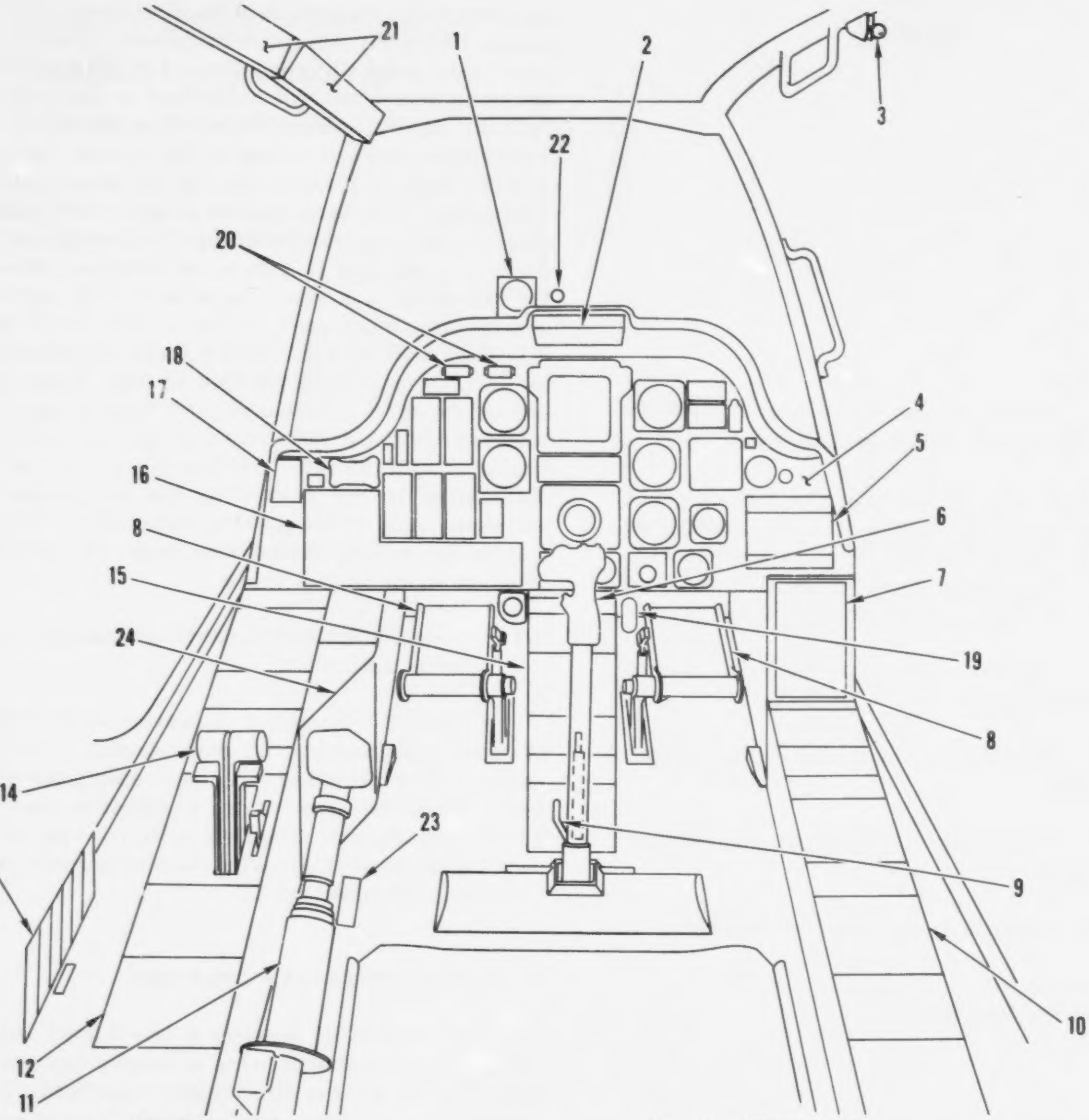
2-11. Crew Station Instruments, Indicators, and Annunciators.

Figures 2-7 through 2-12 provide an overview of instrumentation in both crew stations. Instruments will be discussed with their associated systems. Flight instruments are described in Section XIV of this chapter. Caution, warning, and advisory lights, as well as audio warning signals, are also discussed in Section XIV.

2-12. Windshield and Canopy Panels.

The windshield consists of two heated laminated glass windshields. One is directly forward of the CPG; the other is directly above his head. The canopy consists of five acrylic panels: two on each side of the crew stations and one directly above the pilot.

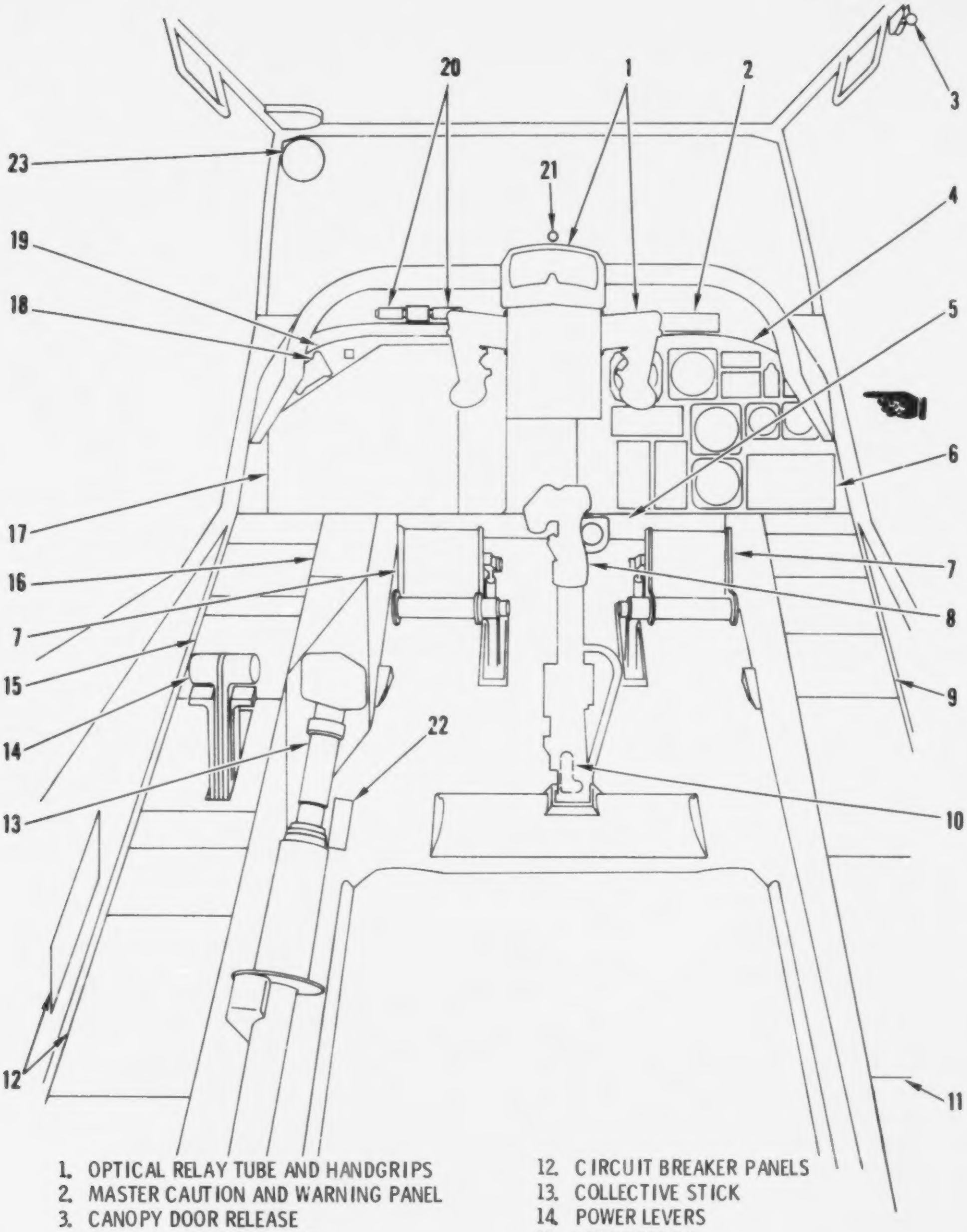
a. **Canopy Panels**. The two canopy panels on the right are independently hinged. They latch and unlatch separately by interior or exterior handles. They swing upward to provide entrance to, and exit from, the crew station. Failure to properly close either canopy causes the CANOPY caution light on the pilot caution/warning panel (figure 2-9) to illuminate. The two canopy panels on the left side are fixed and do not open.



1. STANDBY COMPASS
2. MASTER CAUTION, WARNING PANEL
3. CANOPY DOOR RELEASE
4. INSTRUMENT PANEL
☞ 5. RDRCM, CHAFF, IRCM, AND AN/APR 39(VI) CONTROL PANELS
6. CYCLIC STICK
7. CAUTION, WARNING PANEL
8. DIRECTIONAL CONTROL AND BRAKE PEDALS
9. PEDAL ADJUST LEVER
10. RIGHT CONSOLE
11. COLLECTIVE STICK
12. LEFT CONSOLE
13. AUXILIARY AIR VENT
14. POWER LEVERS
15. CENTER CONSOLE
16. FIRE CONTROL PANEL
17. TAIL WHEEL LOCK PANEL
18. CANOPY JETTISON HANDLE
19. PARKING BRAKE HANDLE
20. ENGINE FIRE PULL HANDLES
21. CIRCUIT BREAKER PANELS
22. BORESIGHT RETICLE UNIT
23. STABILATOR MANUAL CONTROL PANEL
24. STOWAGE BOX

MM01-006L

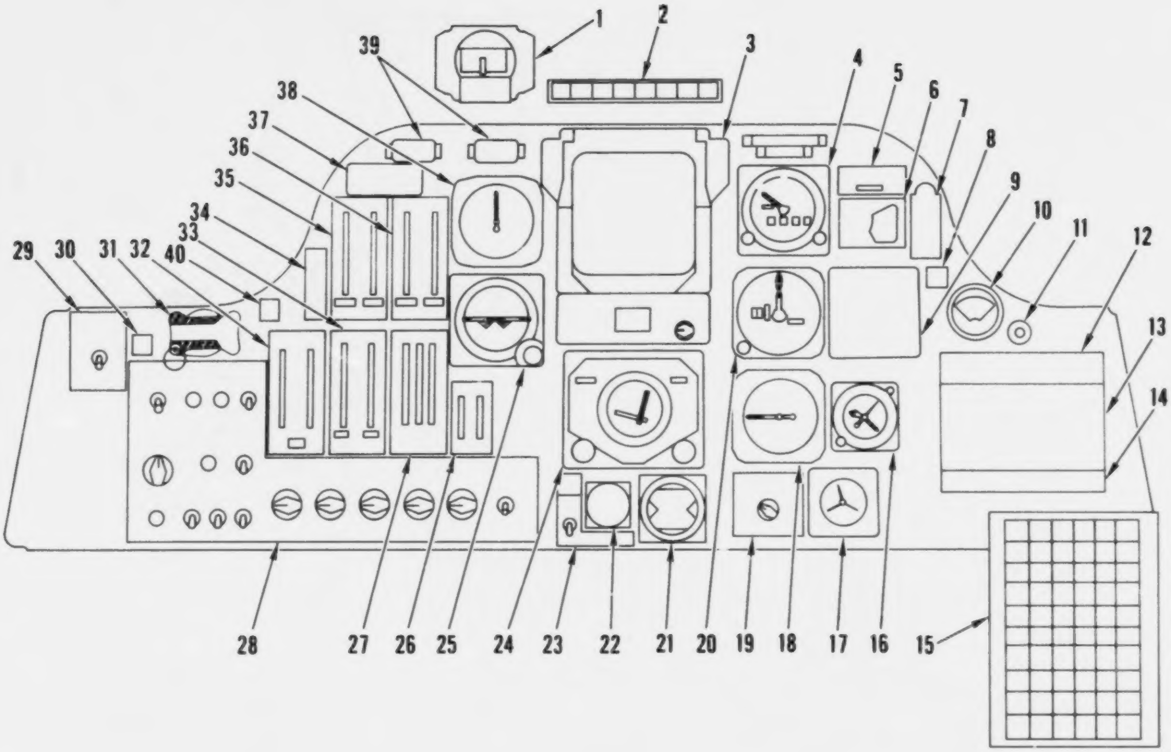
Figure 2-7. Pilot Station Diagram



1. OPTICAL RELAY TUBE AND HANDGRIPS
2. MASTER CAUTION AND WARNING PANEL
3. CANOPY DOOR RELEASE
4. RIGHT INSTRUMENT PANEL
5. CONDITIONED AIR OUTLET
6. CAUTION / WARNING PANEL
7. DIRECTIONAL CONTROL AND BRAKE PEDALS
8. CYCLIC STICK
9. RIGHT CONSOLE
10. PEDAL ADJUST LEVER
11. MAP STORAGE COMPARTMENT
12. CIRCUIT BREAKER PANELS
13. COLLECTIVE STICK
14. POWER LEVERS
15. LEFT CONSOLE
16. DATA ENTRY KEYBOARD
17. FIRE CONTROL PANEL
18. CANOPY JETTISON HANDLE
19. LEFT INSTRUMENT PANEL
20. ENGINE FIRE PULL HANDLES
21. BORESIGHT RETICLE UNIT
22. STABILATOR MANUAL CONTROL PANEL
23. MIRROR

MM01-007B

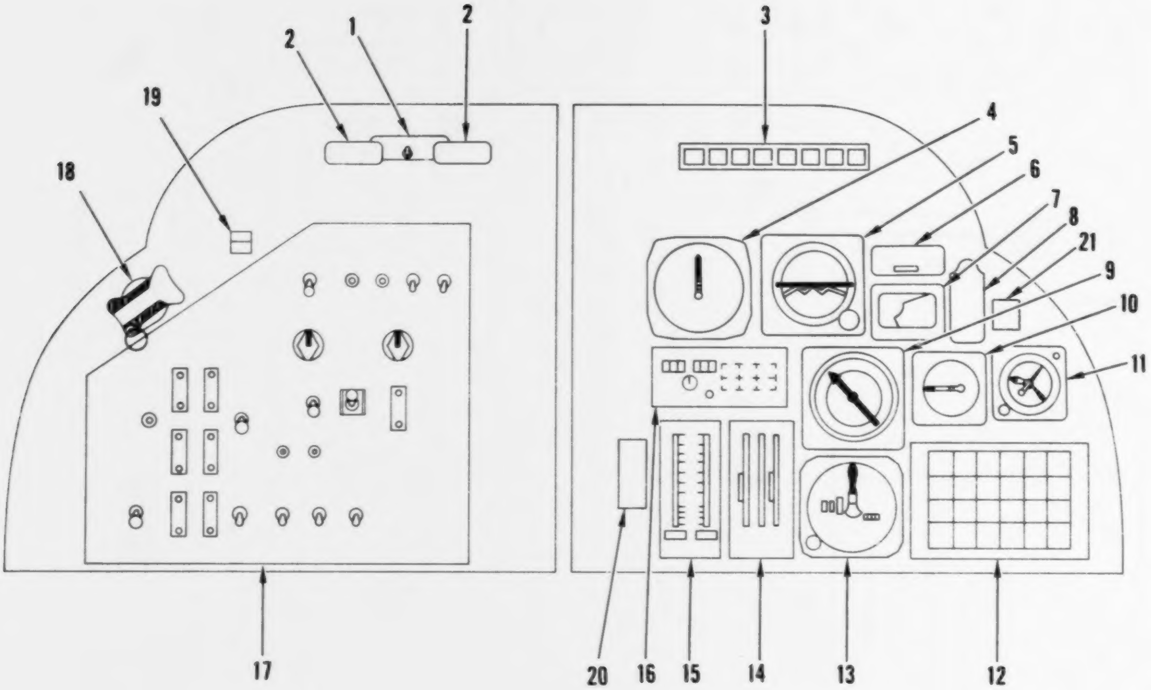
Figure 2-8. Copilot/Gunner Station Diagram



1. STANDBY MAGNETIC COMPASS
2. MASTER CAUTION, WARNING PANEL
3. VIDEO DISPLAY UNIT (VDU)
4. RADAR ALTIMETER
5. RADIO CALL PLACARD
6. STABILATOR POSITION INDICATOR
7. STABILATOR / AIRSPEED PLACARD
8. RADAR JAM INDICATOR
9. RADAR WARNING DISPLAY
10. ICING SEVERITY METER
11. PRESS-TO-TEST SWITCH
12. IR RADAR CONTROL
13. CHAFF DISPENSE PANEL
14. RADAR WARNING PANEL
15. CAUTION, WARNING PANEL
16. CLOCK
17. ACCELEROMETER
18. VERTICAL SPEED INDICATOR (VSI)
19. HARS ALIGNMENTS SWITCH
20. BAROMETRIC ALTIMETER
21. DUAL HYDRAULIC PRESSURE INDICATOR
22. UTILITY ACCUMULATOR PRESSURE GAGE
23. EMERGENCY HYDRAULIC PRESSURE SWITCH
24. HORIZONTAL SITUATION INDICATOR (HSI)
25. STANDBY ATTITUDE INDICATOR
26. ENGINE OIL PRESSURE INDICATOR
27. ENGINE (Np), ROTOR (N_R) INDICATOR
28. FIRE CONTROL PANEL
29. TAIL WHEEL LOCK CONTROL PANEL
30. ARM SAFE INDICATOR
31. CANOPY JETTISON HANDLE
32. FUEL QUANTITY INDICATOR
33. ENGINE GAS GENERATOR (N_G) INDICATOR
34. INSTRUMENT DIM/TEST PANEL
35. ENGINE TURBINE GAS TEMPERATURE (TGT) INDICATOR
36. ENGINE TORQUE INDICATOR
37. FIRE EXTINGUISHER BOTTLE SELECT SWITCH
38. AIRSPEED INDICATOR
39. ENGINE FIRE PULL HANDLES
40. FUEL TRANSFER INDICATOR

MM01-008-1E

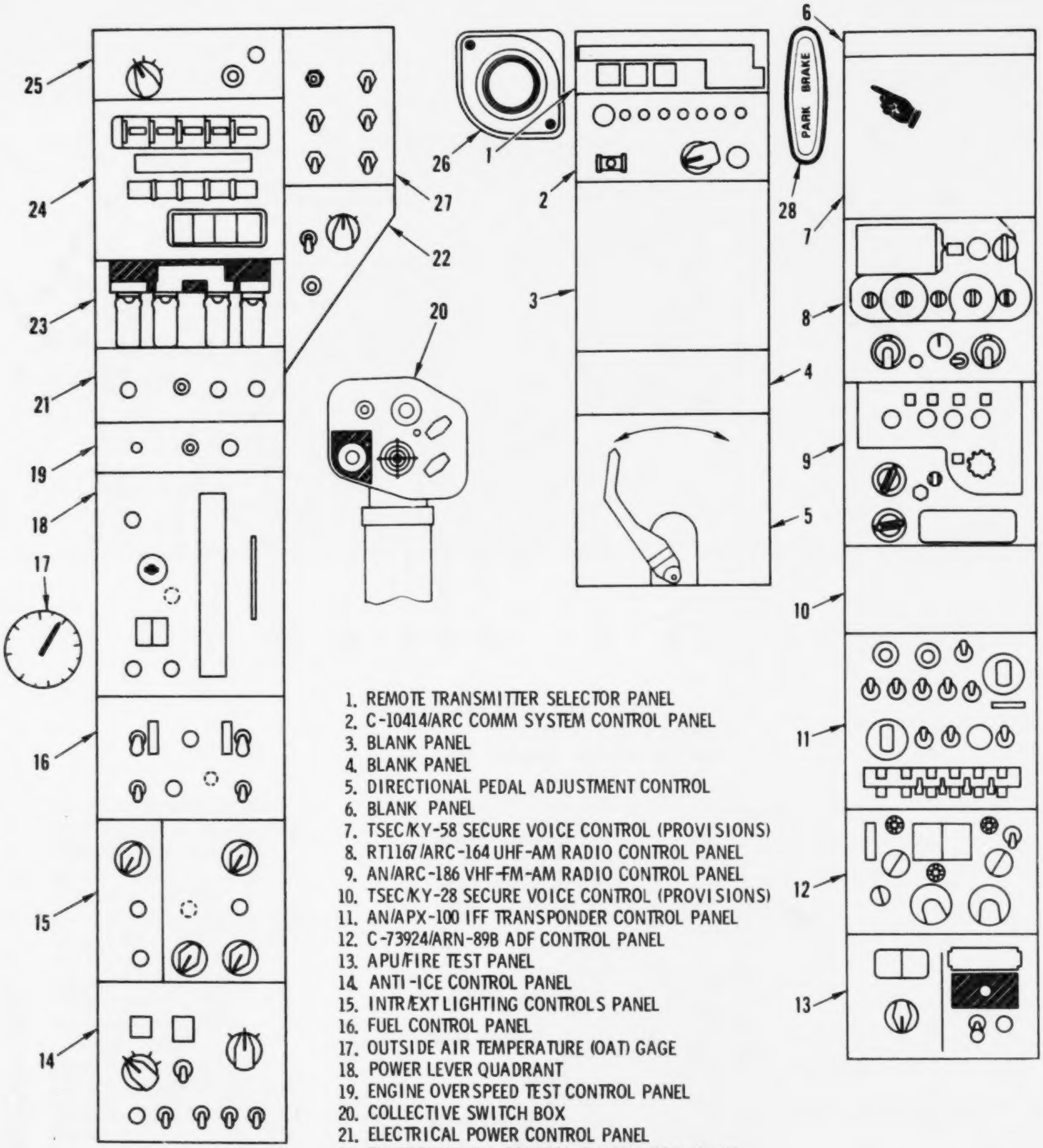
Figure 2-9. Pilot Instrument Panel



1. FIRE EXTINGUISHER BOTTLE SELECT SWITCH
2. ENGINE FIRE PULL HANDLES
3. MASTER CAUTION, WARNING PANEL
4. AIRSPEED INDICATOR
5. REMOTE ATTITUDE INDICATOR
6. RADIO CALL PLACARD
7. STABILATOR POSITION INDICATOR
8. STABILATOR/AIRSPEED PLACARD
9. RADIO MAGNETIC INDICATOR (RMI)
10. VERTICAL SPEED INDICATOR (VSI)
11. CLOCK
12. CAUTION/WARNING PANEL
13. BAROMETRIC ALTIMETER
14. ENGINE (N_P), ROTOR (N_R) INDICATOR
15. ENGINE TORQUE INDICATOR
16. SELECTABLE DIGITAL DISPLAY PANEL
17. FIRE CONTROL PANEL
18. CANOPY JETTISON HANDLE
19. ARM SAFE INDICATOR
20. ENGINE INSTRUMENT DIM/TEST PANEL
21. FUEL TRANSFER INDICATOR

MM01-010F

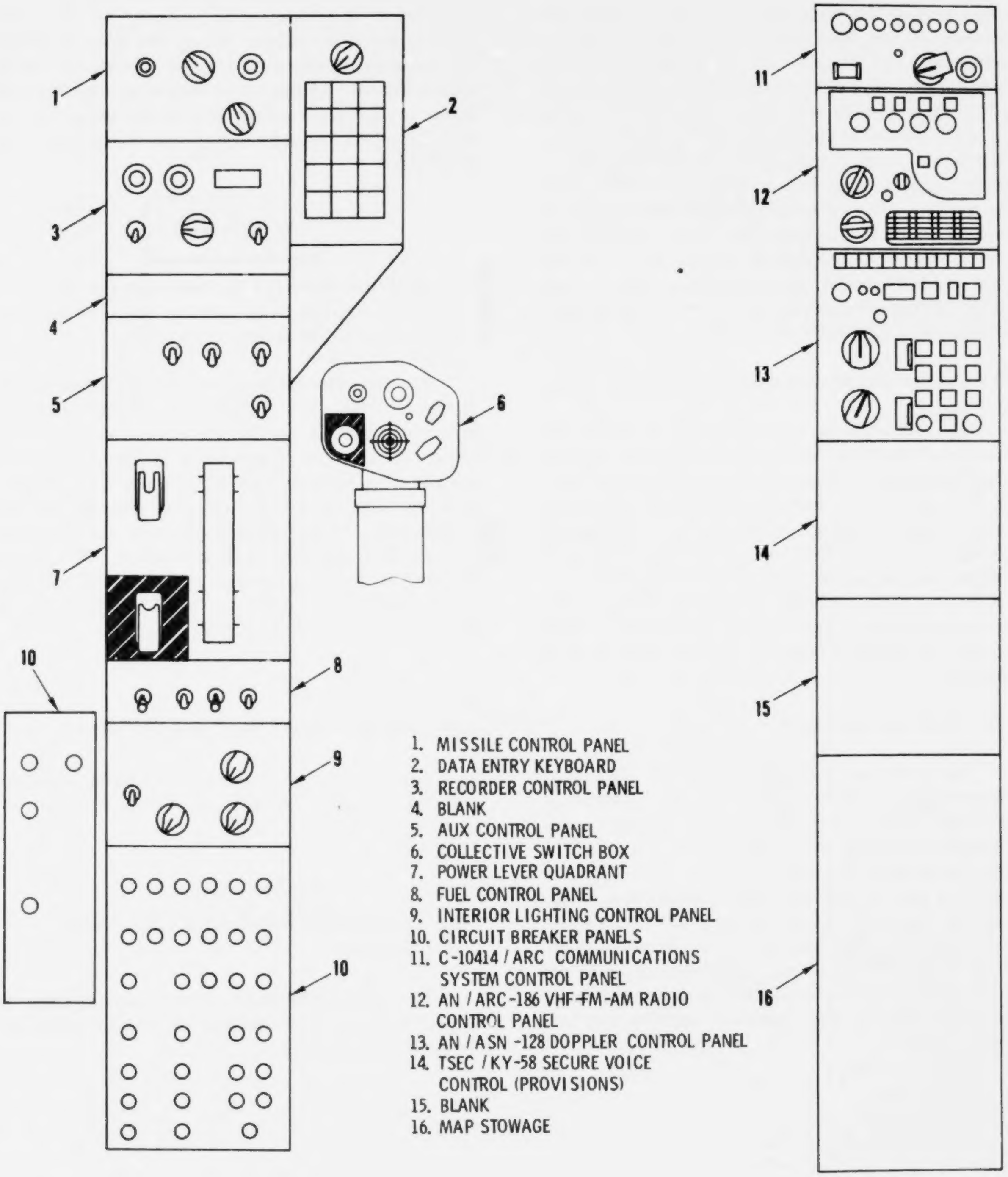
Figure 2-10. Copilot/Gunner Instrument Panel



1. REMOTE TRANSMITTER SELECTOR PANEL
2. C-10414/ARC COMM SYSTEM CONTROL PANEL
3. BLANK PANEL
4. BLANK PANEL
5. DIRECTIONAL PEDAL ADJUSTMENT CONTROL
6. BLANK PANEL
7. TSEC/KY-58 SECURE VOICE CONTROL (PROVISIONS)
8. RT1167/ARC-164 UHF-AM RADIO CONTROL PANEL
9. AN/ARC-186 VHF-FM-AM RADIO CONTROL PANEL
10. TSEC/KY-28 SECURE VOICE CONTROL (PROVISIONS)
11. AN/APX-100 IFF TRANSPONDER CONTROL PANEL
12. C-73924/ARN-89B ADF CONTROL PANEL
13. APU/FIRE TEST PANEL
14. ANTI-ICE CONTROL PANEL
15. INTR/EXT LIGHTING CONTROLS PANEL
16. FUEL CONTROL PANEL
17. OUTSIDE AIR TEMPERATURE (OAT) GAGE
18. POWER LEVER QUADRANT
19. ENGINE OVERSPEED TEST CONTROL PANEL
20. COLLECTIVE SWITCH BOX
21. ELECTRICAL POWER CONTROL PANEL
22. ENVIRONMENTAL CONTROL SYSTEM (ECS) PANEL
23. STORES JETTISON CONTROL PANEL
24. ROCKET CONTROL PANEL (ARCS)
25. MISSILE CONTROL PANEL
26. CONDITIONED AIR OUTLET
27. AUTOMATIC STABILIZATION EQUIPMENT (ASE)PANEL
28. PARKING BRAKE

MM01-009D

Figure 2-11. Pilot Control Consoles



1. MISSILE CONTROL PANEL
2. DATA ENTRY KEYBOARD
3. RECORDER CONTROL PANEL
4. BLANK
5. AUX CONTROL PANEL
6. COLLECTIVE SWITCH BOX
7. POWER LEVER QUADRANT
8. FUEL CONTROL PANEL
9. INTERIOR LIGHTING CONTROL PANEL
10. CIRCUIT BREAKER PANELS
11. C-10414 / ARC COMMUNICATIONS SYSTEM CONTROL PANEL
12. AN / ARC-186 VHF-FM-AM RADIO CONTROL PANEL
13. AN / ASN -128 DOPPLER CONTROL PANEL
14. TSEC / KY-58 SECURE VOICE CONTROL (PROVISIONS)
15. BLANK
16. MAP STOWAGE

MM01-011C

Figure 2-12. Copilot/Gunner Control Consoles

b. **Emergency Exit**. To permit rapid emergency exit of the pilot and CPG, the transparent portions of the four canopy side panels can be jettisoned by means of a detonating cord installation. Any of three canopy jettison handles will initiate canopy side panel jettison. The pilot handle is located at the upper left corner of the pilot instrument panel (figure 2-7). The CPG handle is located at the upper left corner of the CPG panel (figure 2-8). The external ground crew handle is located under a quick-release panel directly forward of the CPG windshield (figure 2-1). To jettison, a safety pin is removed; the handle is then turned 90 degrees and pushed in. All three handles are placarded CANOPY JETTISON.

2-13. Equipment Stowage Compartments.

The aft storage bay (figure 2-1) is for the stowage of tie down devices, protective covers, and other helicopter equipment. The loading conditions for this bay are covered in Chapter 6, Weight/Balance and Loading. The survival equipment storage bay (figure 2-1) is large enough to store a combat helmet, an environmental survival kit, a survival weapon, and a box of field-type rations for each crewmember. The loading limitations for this bay are covered in Chapter 6, Weight/Balance and Loading.

2-14. Crew Member Seats.

The pilot and copilot/gunner seats (figure 2-13) provide ballistic protection and can be adjusted for height only. They are one-piece armored seats equipped with back, seat, and lumbar support cushions. Each seat is equipped with a shoulder harness, lap belt, crotch belt, and inertial reel. The shoulder harness and belts have adjustment fittings and come together at a common attachment point. This provides a single release that can be rotated either clockwise or counterclockwise to simultaneously release the shoulder harness and all belts.

a. **Seat Height Adjustment**. Vertical seat adjustment is controlled by a lever on the right front of the seat bucket. When the lever is pulled out (sideways), the seat can be moved vertically approximately 4 inches and locked at any 3/4-inch interval. Springs counterbalance the weight of the seat. The lever returns to the locked position when released.

WARNING

With the collective in other than the full-down position, the inertia reel control handle may be inaccessible.

b. **Shoulder Harness Inertia Reel Lock Lever**. A two-position shoulder harness inertia reel lock lever is installed on the left front of each seat (figure 2-13). When the lever is in the aft position, the shoulder harness lock will engage only when a forward force of 1-1/2 to 2 g is exerted on the mechanism. In the forward position, the shoulder harness lock assembly is firmly locked. Whenever the inertia reels lock because of deceleration forces, they remain locked until the lock lever is placed in forward and then aft positions.

2-15. Pilot Instrument Panel and Consoles.

The pilot instrument panel is shown in figure 2-9 and the pilot control consoles are shown in figure 2-11.

2-16. Copilot/Gunner Instrument Panel and Consoles.

The Copilot/Gunner instrument panel is shown in figure 2-10 and the control consoles are shown in figure 2-12.

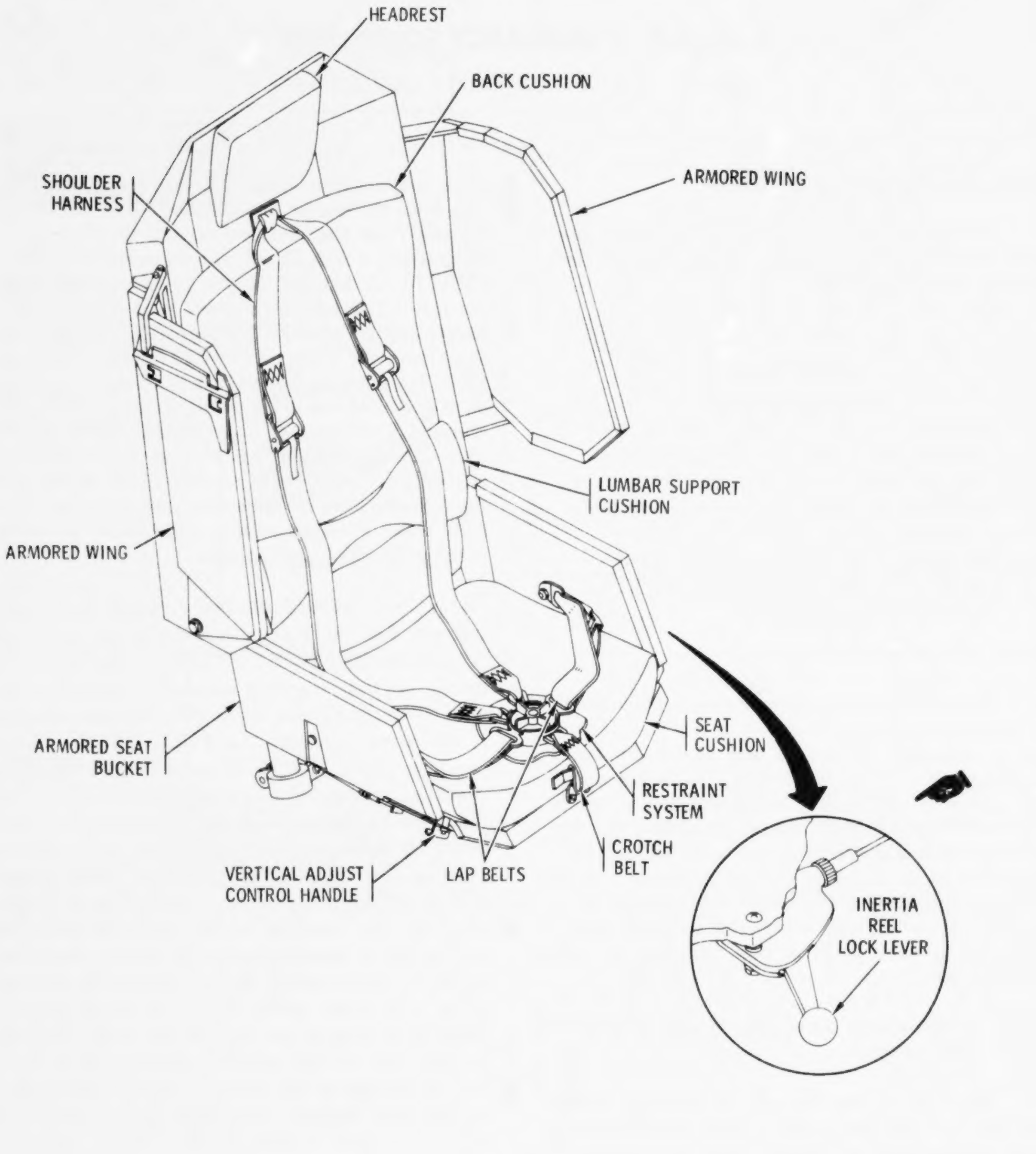

HEADREST
BACK CUSHION
ARMORED WING
SHOULDER HARNESS
LUMBAR SUPPORT CUSHION
ARMORED WING
SEAT CUSHION
ARMORED SEAT BUCKET
RESTRAINT SYSTEM
CROTCH BELT
VERTICAL ADJUST CONTROL HANDLE
LAP BELTS
INERTIA REEL LOCK LEVER
MM01-041B

Figure 2-13. Crewmember Seat (Both Stations)

Section II. EMERGENCY EQUIPMENT

2-17. EMERGENCY EQUIPMENT.

Emergency equipment on the helicopter consists of fire extinguishing equipment and two first aid kits. (See figure 9-1.)

WARNING

Exposure to high concentrations of fire extinguishing agent or decomposition products should be avoided. The gas should not be allowed to contact the skin; it could cause frostbite or low-temperature burns. If agent comes in contact with the skin, seek medical help immediately.

2-18. Portable Fire Extinguisher.

A pressurized fire extinguisher is mounted on a quick release support located in the FAB fairing aft of the right FAB door and above the main landing gear wheel (figure 2-1). It is accessible through a hinged access panel and the panel is marked FIRE EXTINGUISHER INSIDE. The fire extinguisher compound is released by a hand-operated lever on top of the extinguisher. Inadvertent discharge of the bottle is prevented by a breakaway safety wire across the actuating lever. Operating instructions are printed on the extinguisher.

2-19. Engine and Auxiliary Power Unit Fire Detection.

Two optical sensors, which react to visible flames, are located in each engine compartment and in the auxiliary power unit compartment. Three pneumatic fire/overheat detectors are located in the aft deck area. One detector is mounted on the main transmission support, and one on each of the two firewall louver doors. Amplified electrical signals from the sensors located in the engine compartment will illuminate the respective ENG FIRE PULL handle (figure 2-14) in both crew stations. The auxiliary power unit compartment sensors, or the aft deck fire/overheat detectors, will illuminate the FIRE APU PULL handle (figure 2-14) in the pilot station and the FIRE APU segment on the master caution/warning panel in both crew stations. The engine fire pull handles (ENG 1 FIRE PULL and ENG 2 FIRE PULL) are located in similar positions in both crew stations; they are at the upper left corner of the instrument panel. The APU FIRE PULL handle is located on the APU panel on the pilot right console.

a. **Engine and Auxiliary Power Unit Fire-Detector Testing.** Fire pull handle lamps are tested by pressing the PRESS TO TEST pushbutton on the master caution / warning panel in either crew station. Electrical power for the fire detector circuits is obtained through the FIRE DETR circuit breakers (ENG 1, ENG 2, and APU) on the pilot overhead circuit breaker panel (figure 2-32). The fire detector circuits are tested by turning the FIRE TEST DET rotary switch located aft on the pilot's right console (figure 2-14). The switch is spring-loaded to OFF. When set at 1, the first sensor circuit for No. 1 engine, No. 2 engine, the APU, and left and right firewall louver door fire detectors are tested, which causes all fire pull handles to light up. Also, the FIRE APU lights on both master caution/warning panels illuminate. When the DET switch is set at 2, the second sensor circuit for No. 1 and No. 2 engines, the APU, and main transmission support fire detector are tested; and all fire pull handles and both FIRE APU master caution/warning panel segments will illuminate. In either test, failure of a handle to

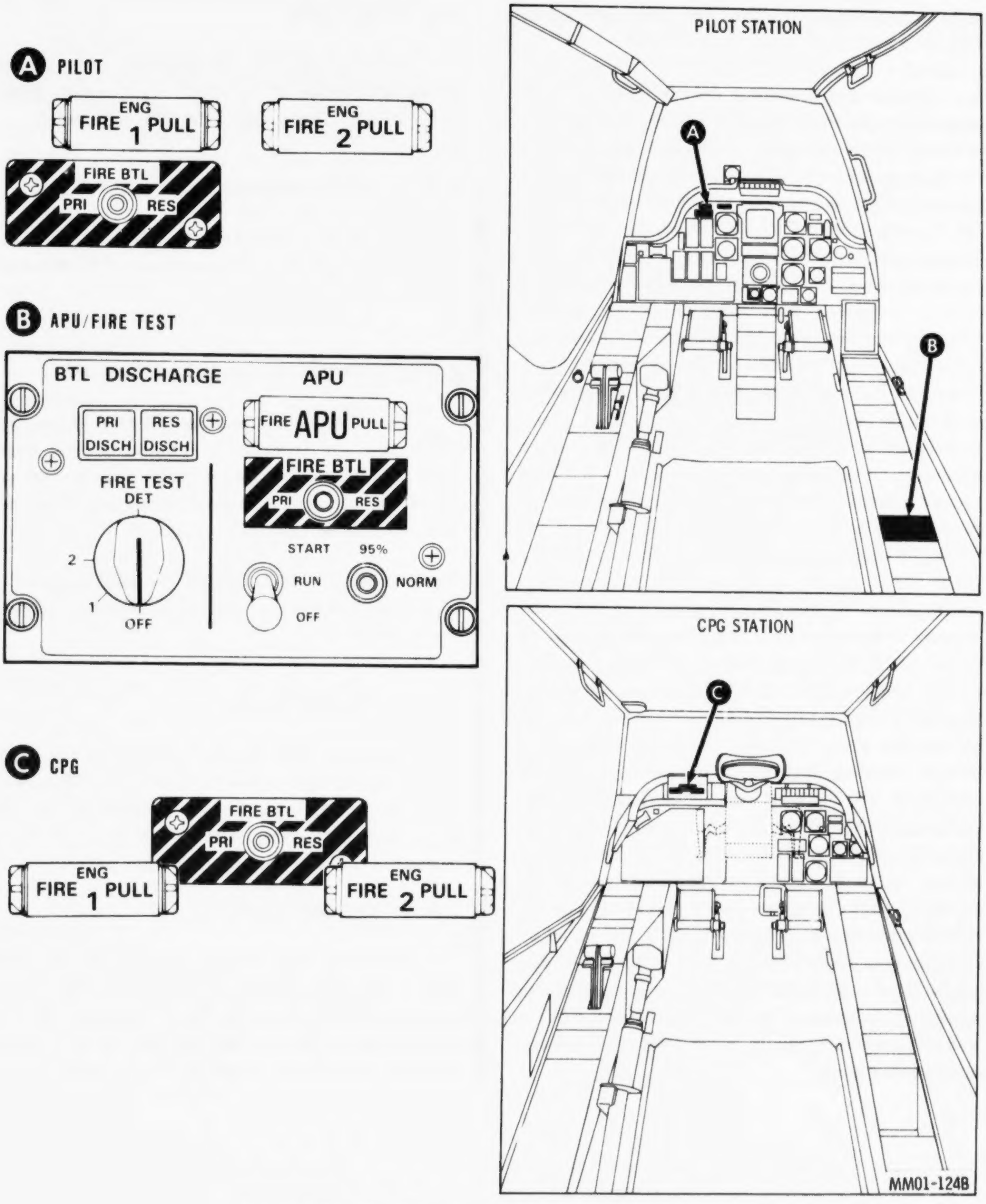

A PILOT
ENG
FIRE 1 PULL
ENG
FIRE 2 PULL
FIRE BTL
PRI
RES
B APU/FIRE TEST
BTL DISCHARGE
PRI DISCH
RES DISCH
FIRE TEST
DET
2
1
OFF
APU
FIRE APU PULL
FIRE BTL
PRI
RES
START
RUN
OFF
95%
NORM
C CPG
FIRE BTL
PRI
RES
ENG
FIRE 1 PULL
ENG
FIRE 2 PULL
PILOT STATION
A
B
CPG STATION
C
MM01-124B

Figure 2-14. Fire Detection and Extinguishing Controls

light up indicates a fault in that particular sensor circuit.

b. **Engine and Auxiliary Power Unit Fire Extinguishing System.** The fire extinguishing agent is stored in two spherical bottles each containing a nitrogen precharge. The bottles, designated as primary (PRI) and reserve (RES), are mounted on the fuselage side of the No. 1 engine firewall. Tubing is installed to distribute the extinguishing agent to either of the engine nacelles or to the auxiliary power unit compartment. Bottle integrity may be checked by inspecting the thermal relief discharge indicator which is viewed from below the left engine nacelle. A pressure gage on each bottle provides an indication of the nitrogen precharge pressure. Each bottle has three discharge valves that can be individually actuated by an electrically ignited pyrotechnic squib. There is one valve for each of the engine nacelles and one for the auxiliary power unit compartment. When a FIRE PULL handle is pulled, four events occur: fuel is shut off to the affected engine, engine cooling louvers to the affected engine close (not applicable to the APU), the appropriate squib firing circuit is armed, and the ENCU is shut off (Not applicable to the APU). The extinguishing agent is not released to the fire area, however, until the FIRE BTL switch, located near each fire pull handle, is activated. The FIRE BTL switch is first set at PRI (primary bottle). When the fire is extinguished, the light in the ENG or FIRE APU PULL handle will go out. If the fire is not extinguished, setting the switch at RES discharges the second bottle. Bottle discharge is indicated on the FIRE TEST panel by illumination of the PRI and RES BTL DISCH displays. Electrical power for the fire extinguishing equipment is obtained by way of the ENG 1, ENG 2, and APU circuit breakers on the pilot overhead circuit breaker panel.

2-20. First Aid Kits.

Two first aid kits are provided: one on the inside, aft portion of the pilot's right canopy panel and one on the lower side of the CPG left console.

2-20.1. Survivability Equipment - CBR Blower.

This subsection describes the Chemical, Biological, Respiratory Filter/Blower (CBR Blower) system.

2-20.2. CBR Blower - General Information.

The CBR blower provides filtered air to the flight crew, when cockpit air is contaminated. Each crew member carries his own CBR blower/mask on board, and attaches it to the external power source, located on the left side of his seat (A).

Refer to TM 3-4240-312-12&P for CBR blower operation, installation and maintenance instructions.

2-20.3. Pilot CBR Blower.

The pilot CBR blower mounts on the CBR blower mounting bracket (A148). The CBR blower receives 28VDC from the No. 1 Essential DC bus and is protected by the **CBR BLWR** circuit breaker (CB94) on the pilot aft circuit breaker panel.

2-20.4. CPG CBR Blower.

The CPG CBR blower mounts on the CBR blower mounting bracket (A149). The CBR blower receives 28VDC from the No. 1 Essential DC bus and is protected by the **CBR BLWR** circuit breaker (CB5) on the CPG No. 2 circuit breaker panel.

2-20.5. Wire Strike Protection System (WSPS)

The wire strike protection system (WSPS) (Figure 2-14A) consists of six cutter assemblies and eleven deflectors. An upper cutter assembly is mounted on top of the pilot station canopy on the left side of the helicopter. A lower cutter assembly is mounted on the bottom of the helicopter, forward of the gun turret bay. A main landing gear cutter assembly is mounted on each main landing gear strut by the lower step on the forward side of the strut. A PNVS cutter assembly is mounted on the top of the TADS/PNVS. A gun turret deflector and cutter assembly is mounted on the forward side of the gun cradle. A forward and aft deflector are mounted on the TADS/PNVS. A hinge deflector is mounted on each of the pilot and CPG door hinges. An upper wiper deflector assembly is mounted by the upper windshield on the left forward side of the CPG station. A lower wiper deflector assembly is mounted by the lower windshield on the right forward side of the CPG station. A tailboom jack pad deflector assembly is mounted on the bottom of the tailboom just forward of the jack pad. A tail landing gear deflector assembly is mounted on the tail landing gear forward of the tail wheel. The wire strike protection system is designed to protect the helicopter from wire obstructions at low levels of flight.

2-21. Emergency Procedures.

Chapter 9 describes emergency procedures.

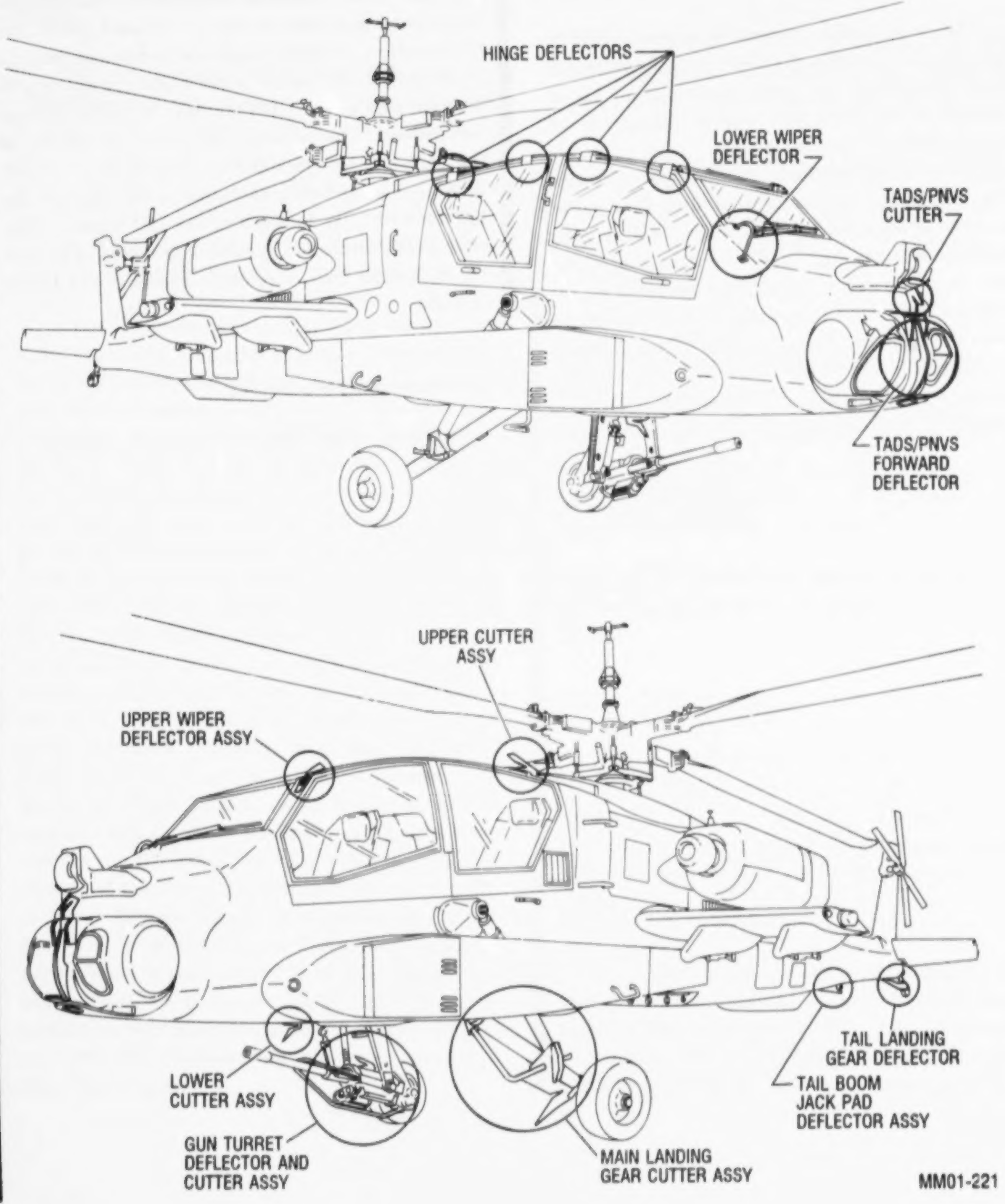

HINGE DEFLECTORS
LOWER WIPER DEFLECTOR
TADS/PNVS CUTTER
TADS/PNVS FORWARD DEFLECTOR
UPPER CUTTER ASSY
UPPER WIPER DEFLECTOR ASSY
TAIL LANDING GEAR DEFLECTOR
TAIL BOOM JACK PAD DEFLECTOR ASSY
LOWER CUTTER ASSY
GUN TURRET DEFLECTOR AND CUTTER ASSY
MAIN LANDING GEAR CUTTER ASSY
MM01-221

Figure 2-14A. Wire Strike Protection System

Section III. ENGINES AND RELATED SYSTEMS

2-22. ENGINES.

The T700-GE-701 engine (figure 2-15) is a front-drive turboshaft engine of modular construction. One horizontally-mounted engine is housed in an engine nacelle on each side of the fuselage aft of the main transmission above the wing. The engine is divided into four modules (figure 2-15): cold section, hot section, power turbine section, and accessory section.

a. **Cold Section Module.** The cold section module (figure 2-15) includes the main frame, diffuser and mid frame assembly, the inlet particle separator, the compressor, the output shaft assembly, and associated components. The compressor has five axial stages and one centrifugal stage. There are variable inlet guide vanes and variable stage-1 and stage-2 stator vanes. Components mounted on the cold section module are: the electrical control unit (ECU), digital electronic control unit (DECU), anti-icing and start bleed valve, history recorder/history counter, ignition system, and electrical cables as well as the accessory section module.

b. **Hot Section Module.** The hot section module (figure 2-15) consists of three subassemblies: the gas generator turbine, the stage one nozzle assembly, and the annular combustion liner.

c. **Power Turbine Section Module.** The power turbine module (figure 2-15) includes a two-stage power turbine and exhaust frame. Mounted on the power turbine module is the thermocouple harness, the torque and overspeed sensor, and the N_P sensor.

d. **Accessory Section Module.** The accessory section module (figure 2-15) includes the top-mounted accessory gearbox and the following components: a hydromechanical unit (HMU), a fuel boost pump, oil filter, oil cooler, alternator, oil lube and scavenge pump, particle separator blower, fuel filter assembly, chip detector, oil/fuel filter bypass sensors, oil/fuel pressure sensor, overspeed and drain valve (ODV), and an air turbine starter.

2-23. Engine Cooling.

Each engine is cooled by air routed through the engine nacelle. Airflow is provided by eductor pumping action of the infrared suppressor. Fixed louvers on the top and bottom of the aft portion of each nacelle and moveable doors in the bottom center forward portion of each nacelle accelerate convective engine cooling after shutdown. The moveable door is shut by engine bleed-air pressure during engine operation and is spring-loaded to open during engine shutdown.

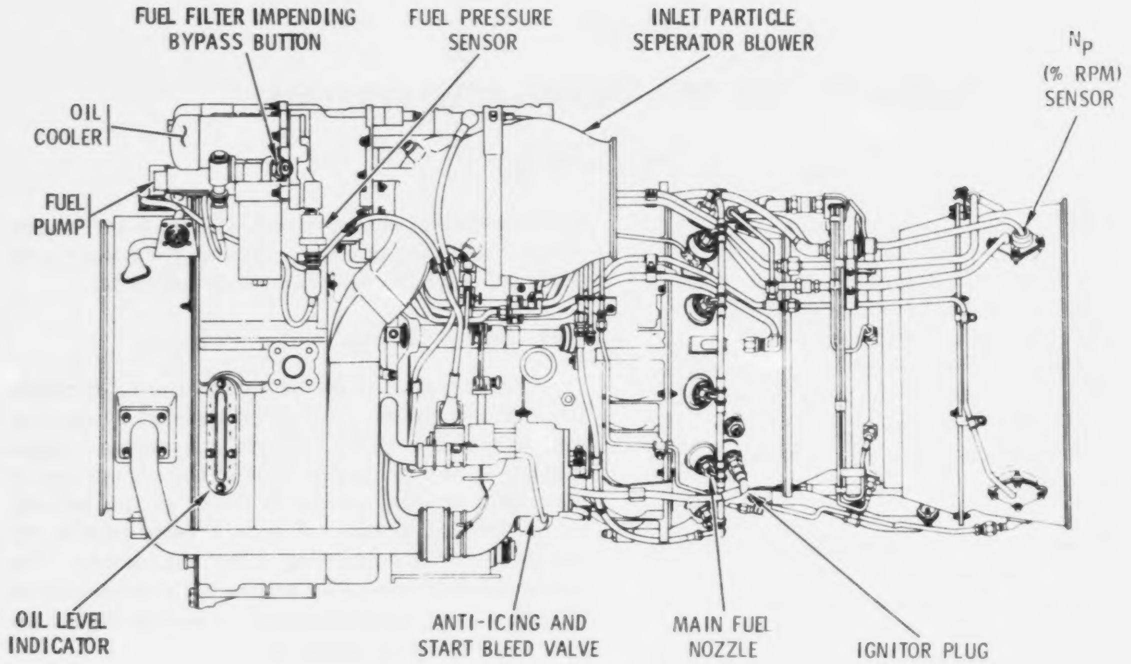
2-24. Engine Air Induction.

The engines receive air through a bellmouth-shaped nacelle inlet at the front of the engine. Air flows around the nose gearbox fairing before entering the engine nacelle inlet. From the inlet, air continues through canted vanes in the swirl frame where swirling action separates sand, dust, and other particles. Separated particles accumulate by centrifugal force in a scroll case. The particles are ejected overboard by a blower which forces them through a secondary nozzle of the infrared suppression device. Clean air, meanwhile, has passed through a deswirl vane which straightens the airflow and channels it into the compressor inlet.

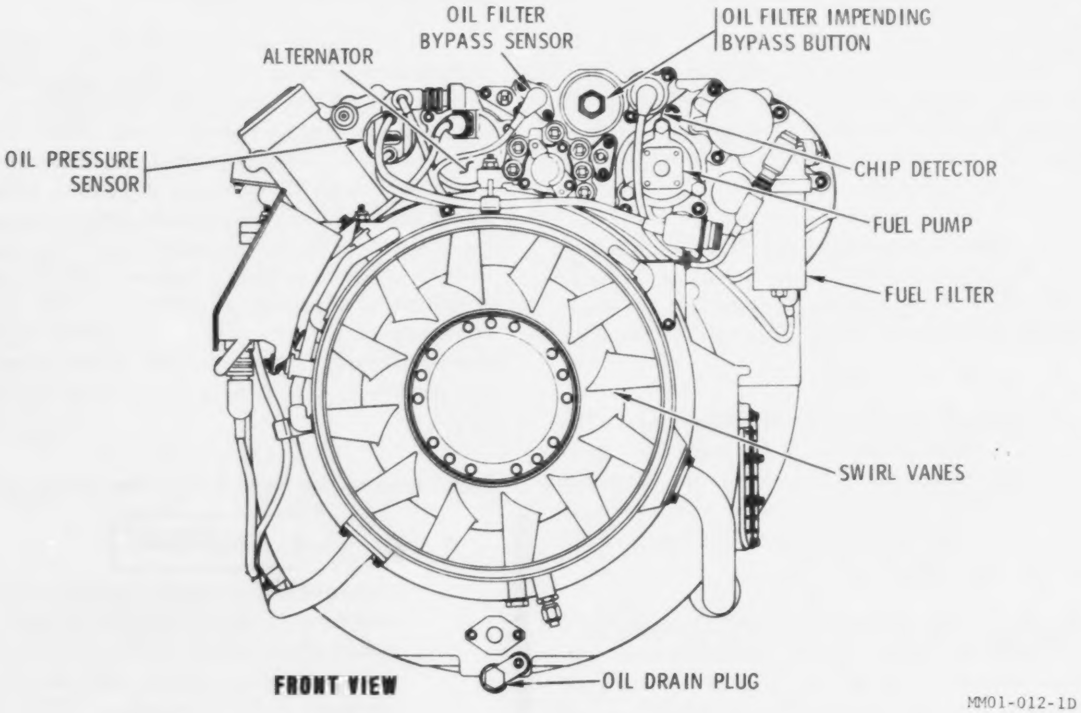
2-25. Engine and Engine Inlet Anti-Icing System.

CAUTION

To prevent damage to engines, the engine anti-ice system shall be activated when the aircraft is flown in visible moisture and outside air temperature (OAT) is less than +5° C (+41°F).

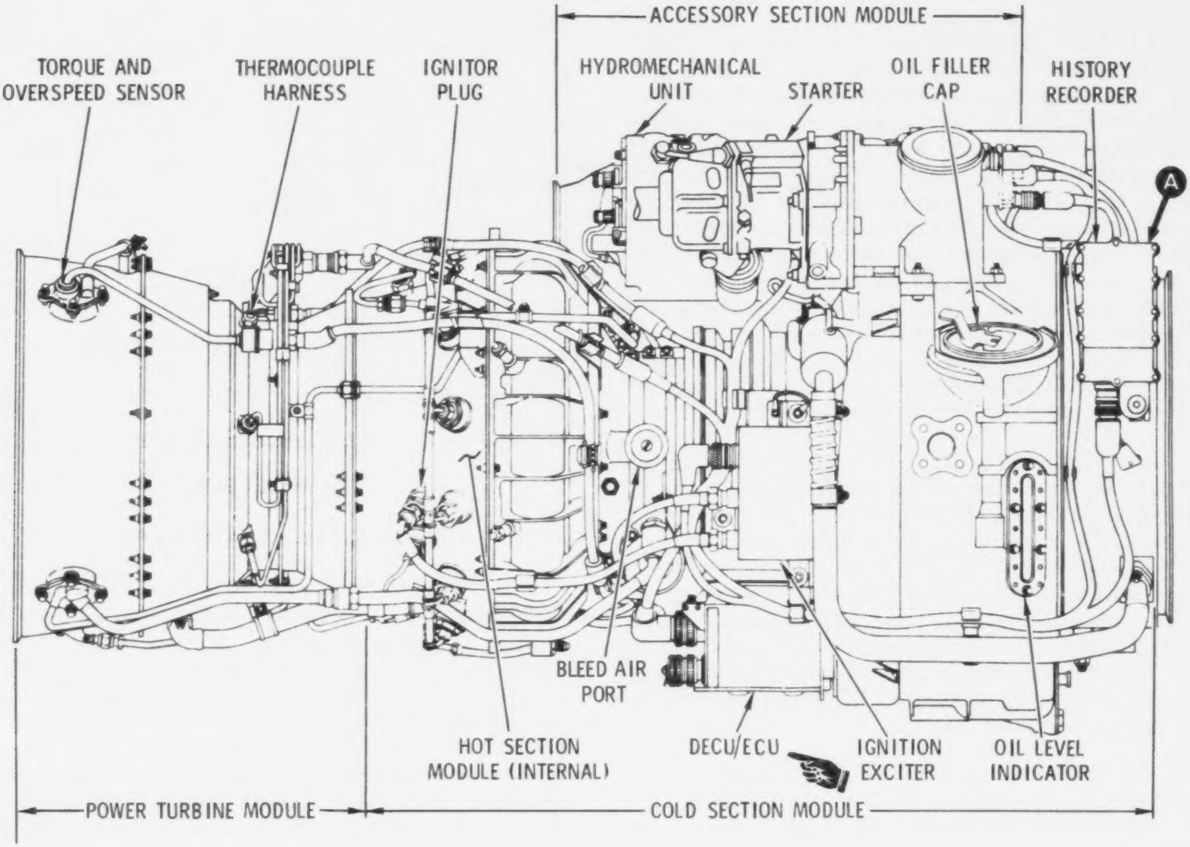

FUEL FILTER IMPENDING BYPASS BUTTON
FUEL PRESSURE SENSOR
INLET PARTICLE SEPERATOR BLOWER
N_p (% RPM) SENSOR
OIL COOLER
FUEL PUMP
OIL LEVEL INDICATOR
ANTI-ICING AND START BLEED VALVE
MAIN FUEL NOZZLE
IGNITOR PLUG

LEFT SIDE

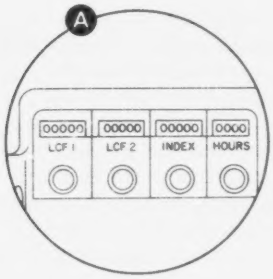

OIL FILTER BYPASS SENSOR
OIL FILTER IMPENDING BYPASS BUTTON
ALTERNATOR
OIL PRESSURE SENSOR
CHIP DETECTOR
FUEL PUMP
FUEL FILTER
SWIRL VANES
OIL DRAIN PLUG
MM01-012-1D

FRONT VIEW

Figure 2-15. T700-GE-701 Engine (Sheet 1 of 2)


ACCESSORY SECTION MODULE
TORQUE AND OVERSPEED SENSOR
THERMOCOUPLE HARNESS
IGNITOR PLUG
HYDROMECHANICAL UNIT
STARTER
OIL FILLER CAP
HISTORY RECORDER
A
BLEED AIR PORT
HOT SECTION MODULE (INTERNAL)
DECU/ECU
IGNITION EXCITER
OIL LEVEL INDICATOR
POWER TURBINE MODULE
COLD SECTION MODULE

RIGHT SIDE


A
00000
00000
00000
0000
LCF 1
LCF 2
INDEX
HOURS

MM01-012-2D

Figure 2-15. T700-GE-701 Engine (Sheet 2 of 2)

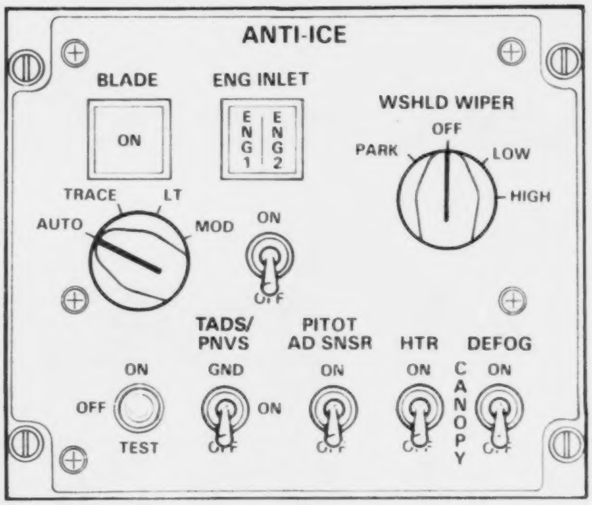
a. The engine anti-ice system is controlled by a two-position ON/OFF ENG INLET toggle switch located on the pilot's ANTI-ICE panel. When the ENG INLET toggle switch is placed to the ON position, the ENG 1 and ENG 2 ANTI-ICE fail lights on the pilot's caution/warning panel and the ENG ANTI-ICE fail light on the CPG's caution/warning panel will illuminate until the nose gearbox fairing electrical heaters reach 205 deg F and the temperature sensors within the engine inlets reach 150 deg F. The time required to reach these temperatures will vary with OAT. When the nose gearbox fairings and the bleed air-heated engine inlet reach operating temperatures, the caution/warning lights will extinguish, the green ENG 1 and ENG 2 advisory lights on the pilot's ANTI-ICE panel will illuminate and remain ON during normal operation of the system.

b. When the engine anti-ice system is turned off, the green advisory lights will extinguish and the ENG ANTI-ICE fail lights will illuminate and remain ON until the engine inlet temperature sensors cool below 150 deg F. The amount of time required for these sensors to cool is dependent on OAT and the length of time the engine anti-ice system has been operating. The ENG ANTI-ICE fail lights may remain illuminated for several minutes after the ENG INLET toggle switch is moved to the OFF position.

c. When the ENG INLET anti-ice switch is OFF, the green advisory lights on the pilot's ANTI-ICE panel indicate when the engine bleed-air valves are open. These lights will illuminate when engine speed is below 91% Ng (bleed valve open) and will extinguish when engine is above 91% (bleed valve closed). When the ENG INLET switch is ON, the advisory lights will remain continuously illuminated unless the nose gearbox fairings over heat +121°C (250°F) or under heat 96°C (205°F) or if the engine inlet section receives anti-ice air at less than 150 °F. If any of these three conditions occur, the green advisory lights extinguish and the ENG ANTI-ICE fail lights illuminate. Continued flight in visible moisture with OAT below +5°C (+41°F) may result in engine damage.

2-26. Engine Fuel Control System.

The engine has a conventional fuel control system: power control lever position and the degree of collective pitch basically establish the power output demands placed on the engines. Engine power is trimmed automatically through interaction of the engine hydromechanical unit (HMU) and the electrical control unit (ECU)/digital electronic unit (DECU). The ECU/DECU of each engine exchanges torque signals with the opposite engine to achieve automatic load-sharing between engines.



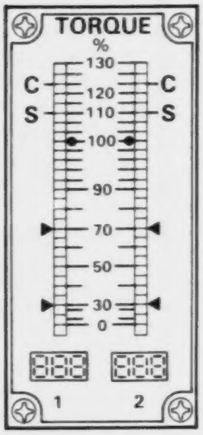
PILOT ANTI-ICE PANEL MM01-143

Figure 2-16. Engine Anti-ice Panel

a. **Fuel Boost Pump.** A low-pressure suction fuel boost pump is installed on the front face of the engine accessory gearbox. It ensures that the airframe fuel supply system is under negative pressure thus reducing the danger of fire in case of fuel system damage. If the FUEL PSI ENG 1 or FUEL PSI ENG 2 segment on the pilot caution / warning panel illuminates at idle speed and above, it could indicate a leak or restriction in the helicopter fuel system or a failed engine boost pump.

b. **Fuel Filter.** A fuel filter is located between the fuel boost pump and the high-pressure pump in the HMU. If this filter becomes clogged and impedes the passage of fuel, a bypass valve permits fuel to bypass the filter. The differential pressure initiating bypass actuates the fuel-pressure bypass sensor thus causing the FUEL BYP ENG 1 or FUEL BYP ENG 2 segment on the pilot caution/ warning panel to illuminate (figure 2-38). An impending filter bypass button on the filter housing pops out when filter element differential pressure indicates impending bypass.

c. **Hydromechanical Unit.** The Hydromechanical Unit (HMU) provides metered fuel to the combuster to control the gas generator (Ng) speed. The HMU contains a high pressure fuel pump to supply fuel to the metering section. The HMU responds to mechanical inputs from the aircrew through the power available spindle (PAS) and the load demand spindle (LDS). The PAS is mechanically connected to the pilot's power levers while the LDS is connected to a bellcrank attached to the collective servo. The HMU regulates fuel



ENGINE TORQUE METER

SIGNAL FAILED	DIAGNOSTIC INDICATION ON TORQUE METER (+/- 3% Tolerance)
DECU	15%
Np DEMAND CHANNEL	25%
LOAD SHARE CHANNEL	35%
TGT CHANNEL	45%
ALTERNATOR POWER	55%
Ng CHANNEL	65%
Np CHANNEL	75%
TORQUE AND OVERSPEED CHANNEL	85%
HOT START PREVENTION CHANNEL	95%
AIRCRAFT 400 Hz POWER	105%
COLLECTIVE CHANNEL	115%

MM01-222

Figure 2-16.1 Signal Validation - Fault Codes

flow and controls positioning at the inlet guide vanes, variable compressor stage 1 and 2 vanes as well as the anti-ice and start bleed valve in response to engine inlet air temperature, compressor discharge air pressure, Ng speed, PAS and LDS positioning, and the Electrical Control Unit (ECU) through the torque motor feedback signals from the HMU to the ECU are provided by the Linear Variable Displacement Transducer (LVDT) to complete the control activated within the HMU at 100-112% Ng speed. The HMU uses signals from the electrical control unit/digital electronic control to interpret fuel requirements and to vary fuel flow for automatic power control. The HMU will additionally provide Ng overspeed protection in the event the gas generator exceeds 108-112%. The reaction of the HMU to an Ng overspeed is the same as for an Np overspeed. When an Ng overspeed is sensed, fuel flow to the combuster is stopped within the HMU which causes the engine to flame out.

d. **Overspeed and Drain Valve (ODV).** The ODV responds to a signal from the ECU and the DECU. Under normal operation, fuel is routed from the HMU via the oil cooler and through the ODV to the combustor. When an overspeed condition is sensed, a signal from the ECU/DECU closes a solenoid in the ODV thus routing fuel back into the HMU. All residual fuel is drained overboard. Fuel flow to the fuel manifold ceases, and the engine flames out.

e. **Electrical Control Unit.** The electrical control unit (ECU) controls the engine and transmits operational information to the crew stations. It is a solid-state device mounted below the engine compressor casing. Powered by the engine alternator, the ECU receives inputs from the thermocouple harness, N_P sensor, torque and overspeed sensor, opposite engine torque for load sharing, N_G signal from the alternator, N_P reference signal from the turbine speed control unit, and a feedback signal from the HMU for system stabilization. The torque-sharing system increases power on the lower-output engine to match it with the higher-output engine. The ECU also receives opposite engine torque inputs to enable contingency power, and can function with a DECU installed on the opposite engine. When this input signal is 51% torque or below, contingency power is automatically enabled. However, contingency power is not applied until the flight crew pulls in collective above 867°C TGT. The ECU automatically allows the normally operating engine to increase its TGT limit thereby increasing its torque output. The overspeed protection system senses a separate N_P signal independently of the governing channel. ECU also provides signals to the N_P indicator, TORQUE indicator, and history recorder. In case of the ECU malfunction, system operation may be overridden by momentarily advancing the engine PWR lever to LOCKOUT and then retarding the lever past the FLY position to manually control engine power. This locks out the ECU from all control/limiting functions except N_P overspeed protection, which remains operational. To remove the ECU from lockout operation, the engine PWR lever must be moved to IDLE, then back to FLY.

f. **Digital electronic control unit.** The digital electronic control unit (DECU) (figure 2-16.1) performs the same functions as the electronic control unit (ECU). It is mounted in the same location as the ECU. The DECU can function with an ECU on the opposite engine and can be overridden like the ECU by monentarily advancing the engine PWR lever to lockout. The DECU which incorporates improved technology, is functionally transparent to the existing ECU except for the following functional and control improvements.

The DECU can be fully powered by either the engine alternator or by 400 HZ, 120 VAC aircraft power. It incorporates logic which will eliminate torque spike signals during engine start-up and shutdown. The DECU contains an automatic hot start preventer (HSP). The DECU also provides signal validation for selected input signals within the electrical control system. Signals are continuously validated when the engine is operating at flight idle and above. If a failure has occurred on a selected input signal, the failed component or related circuit will be identified by a pre-selected fault code. Fault codes will be displayed on the engine torque meter according to figure 2-16.1 which defines fault codes in terms of engine torque. Fault codes will be displayed starting with the lowest code for four seconds ON/two seconds OFF, rotating through all codes and then repeating the cycle. The fault codes will be displayed on the engine torque meter only when all of the following conditions are met:

- Ng less than 20 pencent
- Np less than 35 percent
- Other engine shutdown
- Aircraft 400 HZ power available

The fault codes can be suppressed by depressing the CKT A overspeed test button. The fault codes can also be recalled by again depressing the CKT A overspeed test button. Once a failure has been identified, the fault code will remain available for diagnostic indication until starter dropout on the next engine start.

g. **Hot start prevention.** The hot start prevention (HSP) system is a part of the digital electronic control unit (DECU), and prevents overtemperature during engine start, such as a compressor stall. The HSP system receives power turbine speed (Np) signal, gas generator speed (Ng) signal, and turbine gas temperature (TGT). When Np and Ng are below their respective hot start reference, and TGT exceeds 900 degrees C, an output from the HSP system activates a solenoid in the overspeed and drain valve (ODV). This shuts off fuel flow and causes the engine to shut down. The HSP system will not operate if no aircraft 400 HZ power is provided to the DECU.

h. **Fuel Pressure Warning System.** The engine fuel pressure warning system for each engine consists of a pressure switch that illuminates the FUEL PSI segment on the pilot caution/warning panel. The FUEL PSI ENG 1 and FUEL PSI ENG 2 segments will illuminate when fuel pressure drops below 9 psi.

2-27. Engine Oil System.

Each engine is lubricated by a self-contained, pressurized, recirculating, dry sump system. Included are oil supply and scavenge pumps, an emergency oil system, an integral oil tank, filter, an oil cooler, and seal pressurization and venting. A chip detector that illuminates a crew station warning light is in the line downstream of the scavenge pump.

2-28. Engine Emergency Oil System.

Small oil reservoirs, built into the engine oil sumps, are kept full during normal operation by the oil pump. If oil pressure is lost, oil will bleed slowly out of these reservoirs and be atomized by air jets thus providing an oil mist lubrication for the engine bearings for thirty seconds at 75% N_G. An OIL PSI ENG 1 or OIL PSI ENG 2 light will illuminate on the pilot caution/warning panel when oil pressure drops below 20-25 psi.

2-29. Oil Tank.

Pertinent oil grades and specifications can be found in table 2-8 under materials. The filler port is on the right (figure 2-15). The oil level is indicated by a sight gage on each side of the tank. Oil is supplied to the oil pump via a screen. The scavenge pump returns oil from the sumps to the oil tank through six scavenge screens. A common discharge from the scavenge pump is routed to a single chip detector wired to a CHIPS ENG 1 or CHIPS ENG 2 segment on the pilot caution/warning panel.

2-30. Oil Cooler and Filter.

Scavenge oil passes through an oil cooler before returning to the tank. It is cooled by transferring heat from the oil to fuel routed through the cooler. If the oil cooler pressure becomes too high, a relief valve will open to dump scavenge oil directly into the oil tank. Oil discharged from the oil pump is routed through a disposable element filter. As the pressure differential across the filter increases, the first indication will be a popped impending bypass button. As the pressure increases further, an OIL BYP ENG 1 or OIL BYP ENG 2 light will illuminate on the pilot caution/warning panel. During engine starting, with oil temperature below the normal operating range, pressure may be high enough to close the oil filter bypass sensor switch. In this situation, the caution light or lights will remain on until the oil warms up and oil pressure decreases. The impending bypass indicator has a thermal lockout below +38°C (100°F) to prevent the button from popping.

2-31. Engine Chip Detector.

Each engine chip detector is mounted on the forward side of the accessory gearbox. It consists of an integral magnet, electrical connector, and a housing. A removable screen surrounds the magnet. The detector attracts magnetic particles at a primary chip detecting gap. If chips are detected, a signal is sent to the pilot caution/warning panel to illuminate a CHIPS ENG 1 or CHIPS ENG 2 segment. These chip detectors are of the non-fuzz burning type.

2-32. Ignition System.

Each engine has an ignition exciter unit with two igniter plugs. The exciter unit receives power from its engine alternator. The MASTER IGN keylock switch on the pilot engine power lever quadrant (figure 2-17) is an enabling switch to the ENG START switches. When an ENG START switch is placed to START, pneumatic motoring of the engine starter takes place and the ignition system is energized. Ignition cutout is automatic after the engine starts. Following aborted starts (Chapter 9, Emergency Procedures), the engine must be motored with the ignition system disabled. This is done by placing the ENG START switch to IGN OVRD. Chapter 5 contains the starting cycle limitations.

2-33. Engine Starting System.

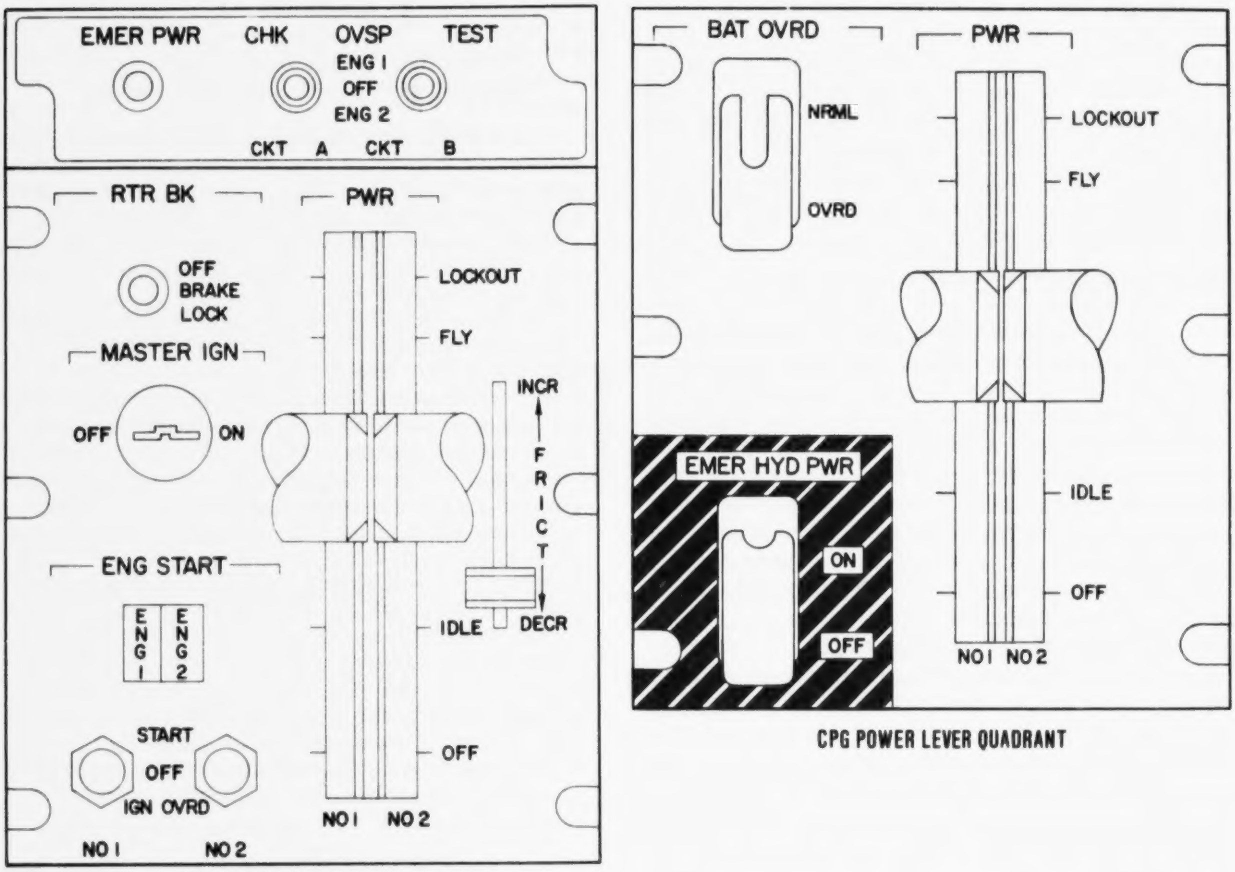
The engine uses an air turbine starter for engine starting. System components for starting consist of the engine starter, a start control valve, an external start connector, check valves, controls, and ducting. Three sources may provide air for engine starts: the shaft driven compressor (SDC) (normally driven by the APU for engine starts), No. 1 engine compressor bleed air, or an externally connected ground source. In any case, the startsequence is the same. With the FUEL switch ON and MASTER IGN switch ON, placing the ENG START switch momentarily to START will initiate an automatic start sequence. This will be evidenced by the illumination of the ENG 1 or ENG 2 advisory light above the ENG START switch on the pilot power lever quadrant. Compressed air is then directed through the start control valve to the air turbine starter. As the air turbine starter begins to turn, an overrun clutch engages which causes the engine to motor. Place the PWR lever to IDLE at 22-28 percent N_G. The starter turbine wheel and gear train automatically disengage from the engine when engine speed exceeds starter input speed. At approximately 52% N_G, air to the starter shuts off, and ignition is terminated.

If the engine does not start, the PWR lever must be returned to OFF and the ENG START switch must be placed at IGN OVRD (which aborts the automatic engine start sequence) momentarily before another start is attempted. Chapter 9 explains abort start procedures, and Chapter 5 contains the start cycle limits.

If the engine is equipped with a digital electronic control unit (DECU), fuel flow to the engine will be automatically shut off if TGT exceeds 900 degrees C during the start sequence. If this occurs, the PWR lever must be returned to OFF and the ENG START switch must be placed in IGN OVRD (which aborts the automatic engine start sequence). TGT must be decreased to below 350 degrees C or wait 25 seconds before another start is attempted.

a. **APU Engine Start.** The auxiliary power unit provides on-board power for system check by ground personnel. The APU is capable of driving the main transmission accessories which include the ac generators, the hydraulic pumps, and the shaft driven compressor (SDC). The APU is normally left on during both engine starts, but it may be shut down after one engine has been started. With the APU shut down, that engine may be used to drive the SDC for starting the second engine. A complete description of the auxiliary power unit appears in Section XII.

b. **No. 1 Engine Bleed-Air Source.** When the No. 1 engine is operating and it is necessary to start the No. 2 engine, bleed air may be used from the No. 1 engine compressor under certain circumstances. This technique is not normally used; however, it is fully automatic, and provides an alternative starting capability if the SDC shaft fails (illuminating the SHAFT DRIVEN COMP caution light) or if the SDC throttle valve or surge valve clogs (Section VI, Pressurized Air System). The starting sequence is the same as for APU starting; only the source of air to the start motor is different. When using this technique to insure an adequate air pressure and flow to the No. 2 engine starter, collective pitch


EMER PWR
CHK
OVSP
TEST
ENG I
OFF
ENG 2
CKT A
CKT B
RTR BK
PWR
OFF
BRAKE
LOCK
MASTER IGN
OFF
ON
LOCKOUT
FLY
INCR
FRICT
DECR
ENG START
ENG I
ENG 2
IDLE
OFF
START
OFF
IGN OVRD
NO I
NO 2
NO I
NO 2
BAT OVRD
PWR
NRML
OVRD
LOCKOUT
FLY
EMER HYD PWR
ON
OFF
IDLE
OFF
NO I
NO 2

PILOT POWER LEVER QUADRANT
AND
ENGINE OVERSPEED TEST CONTROL PANEL

CPG POWER LEVER QUADRANT

MM01-017C

Figure 2-17. Pilot Emergency Check Overspeed Test Panel Power Lever Quadrant and Copilot/Gunner Power Lever Quadrant

must be increased to a value that will increase the N_G of the No. 1 engine to a minimum of 95 percent.

c. **External Source for Engine Starting.** An external air receptacle under the No. 1 engine nacelle provides an attachment point for an air line to start either engine from an external source. The assembly contains a check valve to prevent engine bleed air or SDC pressurized air from being vented overboard. An external air source of 40 psig and 30 pounds per minute (ppm) pressurizes the start system up to the engine start control valves which requires only that electrical power be applied for a normal start sequence.

2-34. Infrared (IR) Suppression System.

The IR suppression system consists of two assemblies: the primary nozzle, and three secondary nozzles. The primary nozzle is mounted to the engine exhaust frame and directs exhaust gases into the secondary nozzle. The three secondary nozzles are attached and sealed to the engine nacelle with an adapter. During engine operation, exhaust gases are cooled by air drawn through the transmission area by a low pressure area created by the eduction action of the primary nozzle. The angles of the primary and three secondary nozzles prevents a direct view of the hot internal engine components. This also creates a low pressure area which causes an eduction action by drawing cooling air through the system. The cool air is mixed with the hot air in the three secondary nozzles which results in cooling the exhaust gases.

2-35. Engine Control System.

The engine control system consists of the engine power lever quadrant, the engine chop controls, the load demand system, and the overspeed protection system.

a. **Engine Power Lever Quadrant.** The power lever quadrants for the pilot and CPG (figure 2-17) allow either crew member to manage engine power. The two quadrant control panels are different, although the PWR levers are identical. Friction, however, can be set on only the pilot levers. The PWR levers have four detent positions: OFF, IDLE, FLY, and LOCKOUT. The pilot detent override controls are mechanical while the CPG's are electrically operated. Movement of either PWR lever moves a cable to mechanically shut off fuel (stop cock) or to set N_G speed. For flight, the lever is advanced to FLY. By moving the PWR lever momentarily to LOCKOUT, then retarding past FLY, N_G speed may be manually controlled. With the PWR lever at LOCKOUT, the TGT limiting system is deactivated, and TGT must be closely monitored and controlled. The overspeed protection system is not disabled in the LOCKOUT position.

CAUTION

Physically confirm that engine chop collar is seated in its latched/centered position.

b. **Pilot and CPG Engine Chop Controls.** The position of a knurled ring on each collective stick grip controls engine chop. The ring is placarded UNLATCH, CHOP, and RESET. When the ring is pushed forward (UNLATCH) and rotated 45 degrees to the right to CHOP, the speed of both engines is reduced to idle. This is done by a switch in the grips that cuts out the power turbine speed reference signals for both engines. At this time, the ENGINE CHOP warning light will illuminate. The ENG 1 OUT and ENG 2 OUT lights and audio will not activate because ENGINE CHOP activation disables this feature. The LOW RPM ROTOR warning light and audio will activate. If the knurled ring is released after turning to CHOP, it will snap back to the center position, but the engines will remain at idle and the ENGINE CHOP warning light will remain illuminated. Retard both power levers to IDLE. If the knurled ring is then turned 45 degrees to the left to RESET, the engines will perform in accordance with PWR lever settings. When the knurled ring is released from RESET, it will snap back to the center position, but the circuit will remain in the reset normal condition. Power. for the engine-cut circuit is obtained by way of the ENG CUT circuit breaker on the pilot overhead circuit breaker panel.

c. **Engine Load Demand System.** When the engine PWR lever is in FLY, the electronic control unit (ECU)/digital electronic control unit (DECU) and HMU respond to collective pitch position to automatically control engine speed and provide required power. During emergency operations when the PWR lever is moved to LOCKOUT and then retarded to an intermediate position, between IDLE and FLY, the engine will respond to collective signals, but control of engine speed is no longer automatic and must be managed manually using the PWR lever.

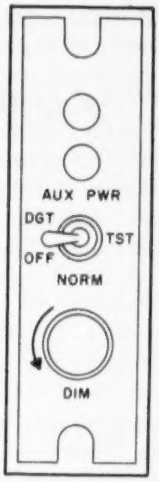
WARNING

The T700-GE-701 engine is designed to shut down when an overspeed condition is sensed. The OVSP TEST circuit trips at 95-97% N_P and should never be performed in flight. A power loss will result.

d. Engine Overspeed Protection System. The overspeed protection system prevents destructive power turbine overspeeds. The system receives power turbine speed signals from the torque and overspeed sensor. When N_P exceeds 119-120% output, the electronic control unit (ECU)/digital electronic control unit (DECU) activates a solenoid in the ODV. This shuts off fuel flow thus causing the engine to shut down. In order to test the system, two circuits are used: CKT A and CKT B. Both circuits must be closed before the overspeed protection test system is activated. When both CKT A and CKT B are closed, the system will trip. This will occur at 95-97% N_P. At this time a signal is sent to the ECU/DECU which closes a solenoid in the ODV and stops fuel flow to the combustor. During the test mode, automatic ignition is applied and remains on until five seconds after the test switches are released. This will ensure a positive relight when fuel flow resumes. The advisory light referred to in table 2-1 is a green light on the EMER PWR CHK OVSP TEST panel and indicates the availability of emergency airframe electrical power. The system normally utilizes engine alternator power. Advisory light power is obtained by way of the ENG START circuit breaker on the pilot overhead circuit breaker panel. Backup power for the No. 1 engine overspeed test is obtained by way of the ENG PWR 1 circuit breaker on the pilot overhead circuit breaker panel; for No. 2 engine, by way of the ENG PWR 2 circuit breaker on the pilot overhead circuit breaker panel.

2-36. Engine Instruments.

A common feature of all vertical-scale instruments is the power-on indication: when electrical power is supplied to these instruments, the blue segment of each vertical-scale is illuminated. Another common feature is indicator-light dimming (not dimming of the edge-lighted panels but dimming of the vertical-scale segments and the digital displays). This dimming is accomplished manually for each crew station by the DIM knob on the engine instrument test panels (figure 2-18) located in each crew station. An additional feature of the pilot's test panel is automatic dimming of the pilot engine instruments by a photoelectric cell located on the test panel. The cell dims or brightens in response to ambient crew station light but may be overridden by manual control. A third common feature of all engine instruments in each crew station is that they share power supplies. Each power supply energizes alternate lamp segments and one digital readout for all engine instruments in each respective crew station. If one power supply fails, every other lamp segment and all of ENG 1 or all of ENG 2 digits will extinguish. In addition, if one of the pilot's power supplies fails, the AUX PWR light on the pilot's test panel will illuminate. The CPG test panel does not have this feature. One of the pilot's power supplies obtains 28 VDC emergency bus power by way of the ENG INST circuit breaker on the pilot's circuit breaker panel. The pilot's other power supply and both CPG power supplies obtain emergency bus power by way of the ENG INST circuit breaker on the CPG main circuit breaker panel. The illuminated segments at the vertical scale instruments are referenced to the adjacent instrument indices and utilize a technique called optimistic scaling. This means, for example, that for proper indication of 100 percent N_R/N_P the segments immediately above the instrument index line for 100 percent should be illuminated.



MM01-123

Figure 2-18. Engine Instrument Test Panel

2-37. Pilot Station Instruments.

All of the pilot engine instruments are on the left side of his instrument panel. These instruments are tested by using a toggle switch on the instrument test panel. When the switch is set at NORM,all instrument lights are operated by their functional inputs. When the switch is set at DGT OFF, all digital displays turn off. When the switch is set at TST, all digital displays indicate 888, and all vertical-scale readings are illuminated. All engine instruments brightness indications in both crew stations are adjusted through use of the DIM rheostat located on the pilot's engine instrument test panel (figure 2-18). The following engine instruments are located on the pilot instrument panel.

a. **Turbine Gas Temperature Indicator (TGT°C x 100).** The TGT indicator is a dual, vertical-scale instrument with dual digital readouts beneath the scales. Temperature is sensed at the power turbine inlets by seven thermocouple probes. These signals are electrically averaged and routed through the electrical control unit/digital electronic control unit (DECU), processed by the signal data converter, and transmitted to the crew station indicators.

b. **Torque Indicator (TORQUE %).** The torque indicator is a dual vertical-scale instrument with dual digital readouts beneath the scales. The engine torque sensor sends pulsed signals to the engine electrical control unit (ECU)/digital electronic control unit (DECU) where torque signals are computed and sent to the crew station indicators.

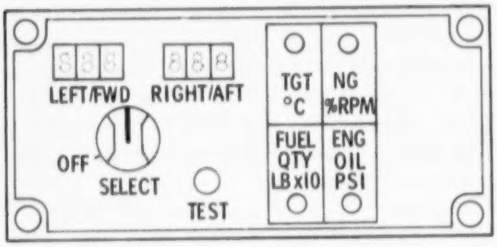
c. **Gas Generator Turbine Speed Indicator (N_G RPM %).** This is a dual, vertical-scale instrument with dual digital readouts beneath the scales. Speed signals are taken from the engine alternators and sent directly to the crew station indicators.

d. **Power Turbine and Main Rotor Speed Indicator (ENG-RTR RPM %).** This is a triple, vertical-scale instrument. The two outer scales (N_P 1 and N_P 2) indicate speeds of the power turbines. The engine power turbine driveshaft sensors transmit pulsed signals to the engine electrical control units/digital electronic control units where they are computed into speed signals and then sent to the crew station indicators. The middle scale registers main rotor speed (N_R) and receives inputs directly from a magnetic pickup-type tachometer generator on the transmission.

e. **Oil Pressure Indicator (ENG OIL PSI x 10).** This is a dual, vertical-scale instrument. Pressure signals are taken from the engine oil system transducers and are displayed on the crew station indicators.

2-38. Copilot/Gunner Station Instruments.

The CPG instrument panel has a power turbine and main rotor speed vertical-scale indicator and an engine torque vertical-scale indicator identical to those on the pilot instrument panel. To compensate for the absence of TGT, N_G, and oil pressure indicators, a selectable digital display (SDD) panel is installed to the right of the CPG engine torque indicator. To obtain a readout, the SELECT knob is turned until a green advisory light is displayed in the desired position on the right side of the panel. When select knob is rotated fully clockwise, no advisory light will be illuminated and the digital readout should be disregarded. Simultaneously, left engine and right engine digital readouts appear in the left upper corner of the panel as well as FWD and AFT call for fuel quantity. The CPG engine instruments are tested by pressing a pushbutton on the selectable digital display (SDD) panel (figure 2-19) which causes all vertical-scale readings to be fully illuminated, and all digital displays to indicate 888. Display indicator brightness is initiated from a control dimmer (figure 2-18) located on the CPG engine instrument test panel. The test panel also has the capability of testing the CPG engine instruments by selecting the TST position of the DGT OFF/NORM/TEST switch. In this position all vertical-scale displays will be fully illuminated and the digital displays will indicate 888. Selecting the DGT OFF position will blank all CPG digital displays.



MM01-016 D

Figure 2-19. Copilot/Gunner Selectable Digital Display Panel

2-39. Engine Caution /Warning Annunciators.

All cautions/warnings for the engines have been discussed in this section. These caution/warning segments, and their fault indicators, will be summarized in Section XIV, Tables 2-6 and 2-7. It should be noted that the CPG caution/warning panel has fewer segments than the pilot caution/warning panel and that specific faults are often not displayed. Illumination of any one of the pilot caution or warning segments that indicates an engine problem will simultaneously illuminate the CPG ENG 1 or ENG 2 segment.

2-40. History Recorder.

An engine history recorder is mounted to the forward right side of each engine (figure 2-15). Signals are sent to the history recorder by the ECU. The recorder displays two readouts of low cycle fatigue (LCF) events, a time-temperature index, and engine operating hours. These readouts cannot be reset to zero. The engine history recorder will only operate with an ECU.

2-40.1. History Counter.

The engine history counter is mounted to the forward right side of each engine (figure 2-15). Signals are sent to the history counter by the digital electronic control unit (DECU). The counter displays two read-outs of low cycle fatigue (LCF) events, a time-temperature index and engine operating hours. These read-outs cannot be reset to zero. The engine history counter will only operate with a DECU and will replace the engine history recorder when a DECU is installed on an engine.

Section IV. FUEL SYSTEM

2-41. FUEL SYSTEM.

The fuel system provides fuel and fuel management provisions (figure 2-20) to operate both engines and the auxiliary power unit (APU). Fuel is stored in two crash-resistant, self-sealing fuel cells: one forward and one aft on the ammunition bay (figure 2-21). Fuel may be transferred from either cell to the other. The system is also equipped to crossfeed (select which fuel cell supplies fuel to the engines). The helicopter has provisions for carrying either two or four external fuel tanks on the wing pylon attach points. Approved primary fuel grades and acceptable alternates are listed in table 2-9.

2-42. Pilot Fuel Control (Management) Panel.

Table 2-2 outlines the effects of switch settings on the pilot fuel management panel (figure 2-20). The following paragraphs contain a description of fuel system provisions controlled by the panel.

a. **Fuel Switch.** Two switches, ENG 1 and ENG 2, control the activation of the crossfeed shutoff valves. In order for fuel to flow to the engines (or crossfeed to the opposite engine if selected), the respective fuel switch must be ON. When in the ON position, the crossfeed switch is enabled. This controls the positioning of the crossfeed valve.

WARNING

The crossfeed switch shall be set to the **NORM** position at all times unless executing emergency procedures for **FUEL PSI ENG 1** and **FUEL PSI ENG 2**. Using the fuel system crossfeed may result in a dual engine flame out if one of the engine fuel valves fails to properly position.

b **Crossfeed Switch.** This switch simultaneously controls the position of both crossfeed/shutoff valves. Three discrete positions, **FWD TK**, **NORM**, and **AFT TK** allow the pilot to select the fuel cell(s) to feed both engines. The **NORM** setting feeds the No. 1 engine from the forward cell and the No. 2 engine from the aft cell. Both engines will feed from either the **FWD TK** or **AFT TK** when selected. If the **ENG 1** or **ENG 2** fire pull handle is pulled, the selected engine crossfeed/shutoff valve automatically closes.

c. **External Tank Switch (EXT TK).** The pilot activates fuel transfer from as many as four auxiliary fuel tanks to the internal fuel cells by positioning the switch to ON. The switch opens the auxiliary fuel tank shutoff valve and the two transfer shutoff valves. Opening the auxiliary fuel tank shutoff valve allows pressurized air to force fuel from the left auxiliary fuel tank into the forward fuel cell and from the right auxiliary fuel tank into the aft fuel cell. When all auxiliary tanks are empty, the EXT EMP caution light on the pilot caution/warning panel, illuminates.

NOTE

The REFUEL VALVE switch (located on the external fuel servicing panel) must be closed for operation of the TRANS switch to be effective. The transfer pump will not transfer fuel if the refuel valve is open.

d. **Transfer Switch (TRANS).** The **TRANS** switch controls the position of the fuel transfer air valve. The fuel transfer air valve directs pressurized air to the bi-directional transfer pump which allows fuel transfer between fuel cells. With the switch in the **TO AFT** or **TO FWD** position, pressurized air is directed to the air motor which turns the transfer pump and transfer fuel forward or aft.

e. **BOOST Switch.** The boost pump (located in the aft fuel cell) is used for starting the engines and when the **FUEL PSI ENG 1** and **FUEL PSI ENG 2** caution lights illuminate.

Table 2-2. Pilot Fuel Control Panel Switch Functions

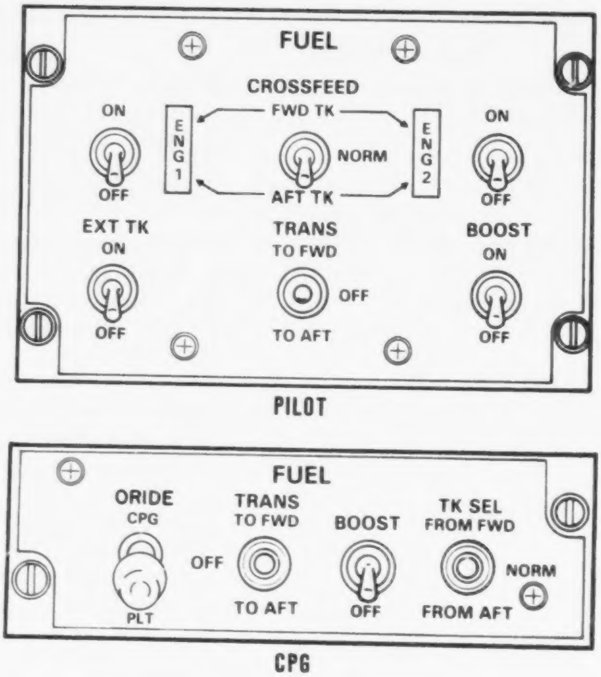
Switch Position	Result	Indication
ENG 1 set OFF	Energizes fuel crossfeed/shutoff valve of the No. 1 engine to the closed position thus shutting off fuel flow to that engine.	None
ENG 1 set ON	Energizes fuel crossfeed/shutoff valve of the No. 1 engine to the position commanded by the CROSSFEED switch.	None
ENG 2 set OFF	Energizes fuel crossfeed/shutoff valve of the No. 2 engine to the closed position thus shutting off fuel flow to that engine.	None
ENG 2 set ON	Energizes fuel crossfeed/shutoff valve of the No. 2 engine to the position commanded by the CROSSFEED switch.	None
CROSSFEED set FWD TK	Both engines feed from the forward fuel cell.	FWD cell fuel quantity indicators register fuel decrease while AFT indicators remain constant.
CROSSFEED set NORM	ENG No. 1 feeds from the forward fuel cell; ENG No. 2 feeds from the aft fuel cell.	Both fuel quantity indicators register fuel decrease from consumption.
CROSSFEED set AFT TK	Both engines feed from the aft fuel cell.	AFT cell fuel quantity indicators register fuel decrease while FWD indicators remain constant.
EXT TK switch set ON	Pressurized air is made available to all external tanks for transferal of fuel to the main fuel cells.	Both fuel quantity indicators register fuel increase during fuel transfer operation.
TRANS set TO FWD	Fuel is being pumped from AFT cell to FWD cell by the transfer pump.	AFT cell fuel quantity indicators register fuel decrease while FWD cell indicators register fuel increase.
TRANS set TO AFT	Fuel is being pumped from FWD cell to AFT cell by the transfer pump.	FWD cell fuel quantity indicators register fuel decrease while AFT cell indicators register fuel increase.
BOOST set ON	Pneumatically driven boost pump (in AFT cell) is delivering fuel to both engine CROSSFEED/ SHUTOFF VALVES.	BOOST PUMP ON segment of C/W panel illuminates. (Crossfeed must be set to AFT TK in order to latch BOOST switch.)

electrically opens the boost pump shutoff valve which directs pressurized air to the air driven boost pump. When the switch is in the OFF position, the engines receive fuel (through a suction feed system) via the engine-mounted fuel pumps. When the boost switch is in the ON position the engine crossfeed/shutoff valves automatically position to feed both engines from the aft fuel cell. The boost pump is automatically started and shut down during the engine start sequence. Shutdown occurs at approximately 52% N_G. It should be noted that the pilot crossfeed switch must be in the AFT TK position in order for the BOOST switch to latch on.

2-43. CPG Fuel Management Panel.

Table 2-3 outlines the effects of switch settings on the CPG fuel management panel (figure 2-20). The following paragraphs contain a description of fuel system provisions controlled by the panel.

a. **Override Switch (ORIDE).** With the ORIDE switch in the PLT positin, only the pilot fuel panel switches have control of fuel system operation. When the override switch is placed in the CPG position, the CPG fuel panel switches are enabled. The switches that are not duplicated on the CPG FUEL panel are still active on the pilot FUEL panel (i.e., ENG 1/2 fuel switches, EXT TK and Boost switch).


FUEL
CROSSFEED
ON
OFF
ENG 1
FWD TK
NORM
AFT TK
ENG 2
ON
OFF
EXT TK
ON
OFF
TRANS
TO FWD
OFF
TO AFT
BOOST
ON
OFF
PILOT
FUEL
ORIDE
CPG
PLT
TRANS
TO FWD
OFF
TO AFT
BOOST
OFF
TK SEL
FROM FWD
NORM
FROM AFT
CPG

MM01-015D

Figure 2-20. Pilot and Copilot/Gunner Fuel Control Panels

Switch Position	Result	Indication
ORIDE set PLT	Only the pilot fuel control panel is enabled.	None
ORIDE set CPG	CPG fuel control panel is enabled.	None
TRANS switch	See Table 2-2.	
BOOST switch	See Table 2-2.	
TK SEL set FROM FWD	See Table 2-2, CROSSFEED set FWD TK.	
TK SEL set NORM	See Table 2-2, CROSSFEED set NORM.	
TK SEL set FROM AFT	See Table 2-2, CROSSFEED set AFT TK.	

b. **Transfer Switch (TRANS).** Operates the same as the pilot TRANS switch (paragraph 2-42d, above).

WARNING

If the fuel **BOOST** switch is activated with the CPG **ORIDE** switch in the **CPG** position, the crossfeed/shutoff valves reposition to the aft tank. This condition may result in a dual engine flameout if the crossfeed does not properly position.

c. **BOOST Switch.** Operates the same as the pilot BOOST switch (paragraph 2-42e, above).

d. **Tank Select Switch (TK SEL).** Operates the same as the pilot CROSSFEED switch (paragraph 2-42b, above).

2-44. Fuel Quantity Indicators.

The pilot vertical-scale fuel quantity indicator indicates the quantity (in pounds X 10) of fuel remaining in the forward and aft fuel cells. A digital display at the bottom of the indicator shows the combined total of remaining fuel (in pounds X 10). The CPG selectable digital display (SDD) indicates the pounds of fuel remaining in the forward and aft fuel cells. The SELECT knob is rotated until the FUEL QTY X 10 display is illuminated thus causing the pounds of fuel remaining in each cell to appear on the digital display. Combined total fuel is not indicated. The fuel quantity transmitters are capacitance-type transmitters. There are three fuel quantity transmitters: two are in the forward fuel cell because of the shape of the fuel cell, and one is in the aft fuel cell. The transmitters provide data to the fuel signal conditioner which, in turn, provides a readout to the fuel quantity indicators in the crew stations.

2-45 Fuel System Caution / Warning Lights.

Fuel system caution/warning segments on the caution/warning panel are discussed in Section XIV, tables 2-5 and 2-6. Their positions on the caution/warning panel are shown in figure 2-38 of the same section. The Fuel Transfer indicators are shown in figures 2-9 and 2-10 of Sectioin I. Both indicators will illuminate when fuel transfer is selected by either crew member.

2-46. Auxiliary Fuel Tank.

For ferry missions, there are provisions for as many as four external fuel tanks to be carried on the wing pylon attachment points. The auxiliary tanks can be jettisoned in the same manner as any other externally mounted stores.

2-47. Refueling Provisions.

All fuel service points are located on the right side of the helicopter. For all refueling operations. the REFUEL valve switch must be placed in the OPEN position then CLOSED after completion of refueling. Section XV contains fuel specifications and weights. Chapter 6 describes the effects of fuel loading on weight and balance.

a. **Gravity Filling.** The forward and aft cells and the external auxiliary tanks are gravity-filled separately. Fuel cell filler ports are located forward and aft of the wing. Refueling time required for gravity refueling depends on the flow-rate capability of the servicing equipment. Section XV contains specific filling procedures.

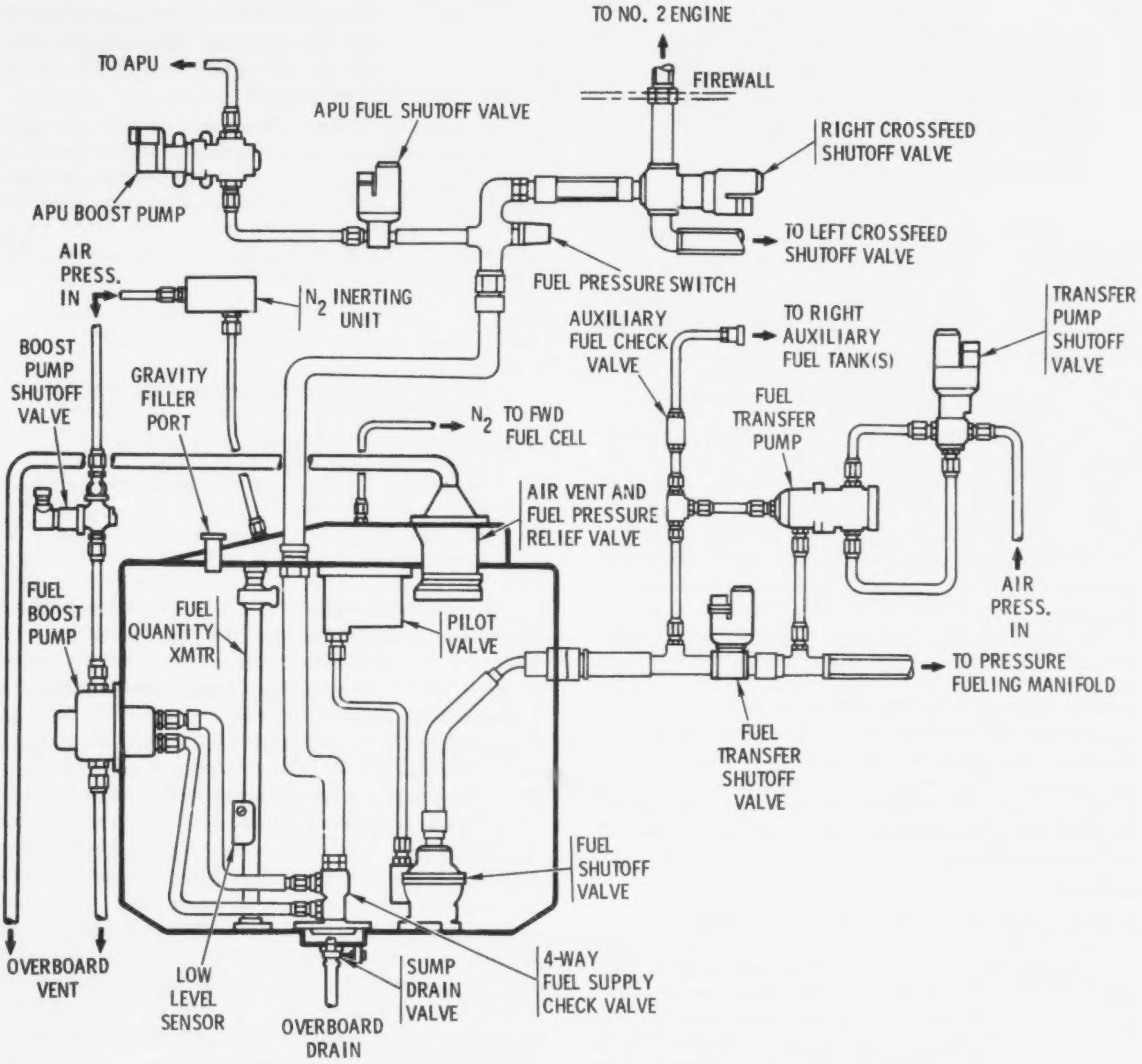
NOTE

For gravity refueling, the closed vent system requires the refuel valve to be open in order to obtain maximum fill above the opening of the filler neck. When fuel has reached this level, the fuel flow rate will have to be decreased to accommodate the restricted vent flow rate.

b. **Pressure Refueling.** The pressure service manifold, located forward of the right wing, has two adapters for accommodating either a single point adapter (SPA) or a closed-circuit adapter (CCA). Using either nozzle, forward and aft cells may be filed separately or simultaneously dependent upon the REFUELING PANEL switch settings (figure 2-39). The shutoff valve at the bottom of each fuel cell responds to an adjoining float-type pilot valve at the top of the cell. This valve will automatically stop fuel flow when the cell is full. Shutoff is set to allow space for a 3% expansion in each cell. The IND switch to the left of the FUEL QTY indicator on the refueling panel energizes the quantity indicator and advisory lights. After refueling, the REFUEL VALVE switch must be returned to the CLOSED position, or fuel transfer from cell-to-cell cannot be accomplished by either crew member. The inside panel of the refueling panel access door contains servicing instructions. Section XV contains complete pressure refueling procedures.

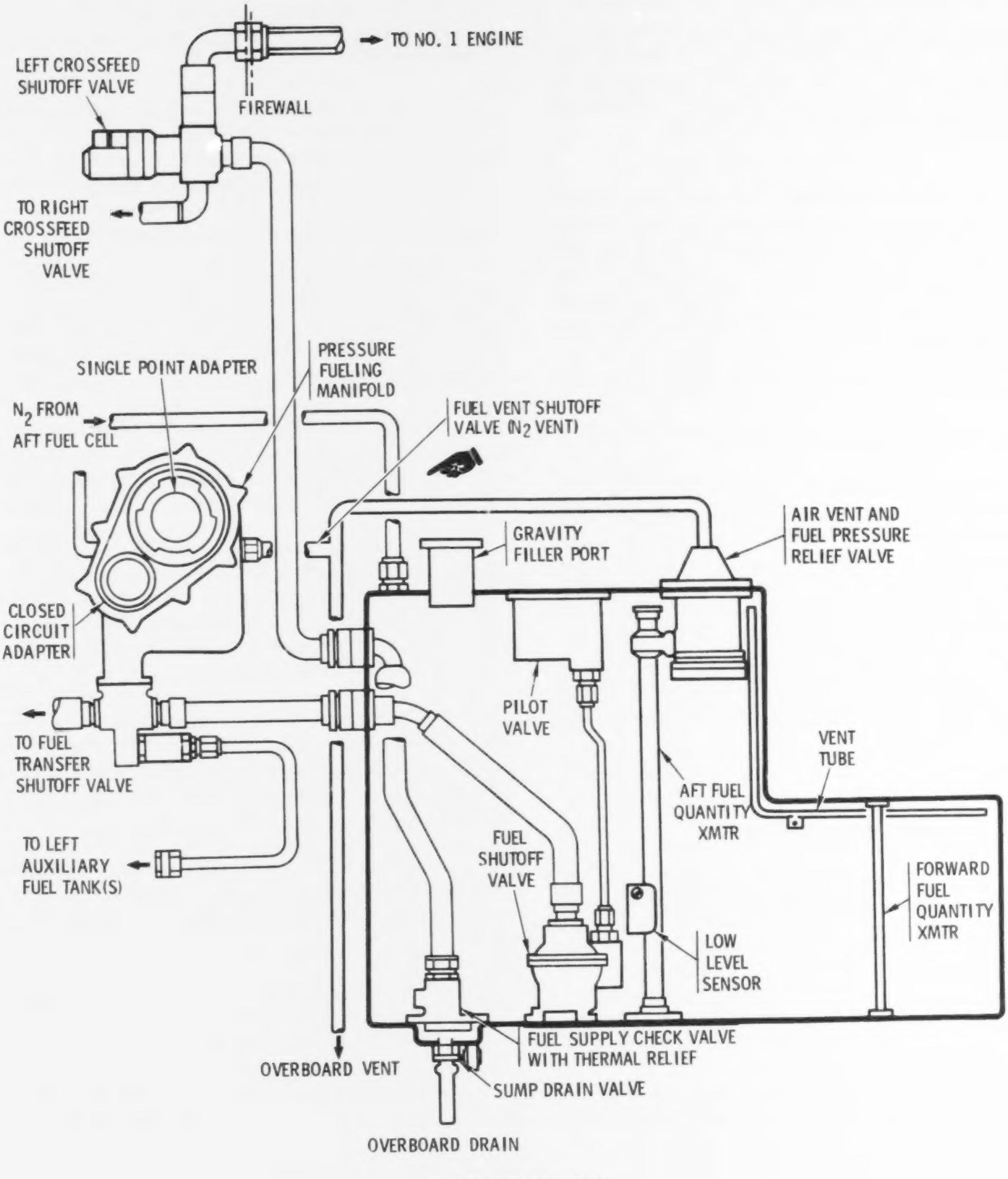
2-48. Auxiliary Power Fuel Supply.

The APU receives its supply of fuel from the aft fuel cell. Fuel is routed from the aft cell through the APU fuel shutoff valve to the APU boost pump and on to the APU.


TO NO. 2 ENGINE
TO APU
FIREWALL
APU FUEL SHUTOFF VALVE
RIGHT CROSSFEED SHUTOFF VALVE
APU BOOST PUMP
TO LEFT CROSSFEED SHUTOFF VALVE
AIR PRESS. IN
N_2 INERTING UNIT
FUEL PRESSURE SWITCH
AUXILIARY FUEL CHECK VALVE
TO RIGHT AUXILIARY FUEL TANK(S)
TRANSFER PUMP SHUTOFF VALVE
BOOST PUMP SHUTOFF VALVE
GRAVITY FILLER PORT
N_2 TO FWD FUEL CELL
FUEL TRANSFER PUMP
AIR VENT AND FUEL PRESSURE RELIEF VALVE
AIR PRESS. IN
FUEL BOOST PUMP
FUEL QUANTITY XMTR
PILOT VALVE
TO PRESSURE FUELING MANIFOLD
FUEL TRANSFER SHUTOFF VALVE
FUEL SHUTOFF VALVE
OVERBOARD VENT
LOW LEVEL SENSOR
SUMP DRAIN VALVE
OVERBOARD DRAIN
4-WAY FUEL SUPPLY CHECK VALVE
AFT FUEL CELL

MM01-040-2C

Figure 2-21. Fuel System (Sheet 1 of 2)


TO NO. 1 ENGINE
LEFT CROSSFEED SHUTOFF VALVE
FIREWALL
TO RIGHT CROSSFEED SHUTOFF VALVE
SINGLE POINT ADAPTER
PRESSURE FUELING MANIFOLD
N_2 FROM AFT FUEL CELL
FUEL VENT SHUTOFF VALVE (N_2 VENT)
GRAVITY FILLER PORT
AIR VENT AND FUEL PRESSURE RELIEF VALVE
CLOSED CIRCUIT ADAPTER
PILOT VALVE
TO FUEL TRANSFER SHUTOFF VALVE
VENT TUBE
AFT FUEL QUANTITY XMTR
TO LEFT AUXILIARY FUEL TANK(S)
FUEL SHUTOFF VALVE
FORWARD FUEL QUANTITY XMTR
LOW LEVEL SENSOR
FUEL SUPPLY CHECK VALVE WITH THERMAL RELIEF
OVERBOARD VENT
SUMP DRAIN VALVE
OVERBOARD DRAIN

FORWARD FUEL CELL

MM01-040-1D

Figure 2-21. Fuel System (Sheet 2 of 2)

a. **APU Shutoff Valve.** The APU fuel shutoff valve is controlled by the APU switch (OFF-RUN-START). When the switch is moved to the RUN position, the shutoff valve is electrically opened to allow fuel flow to the APU boost pump. If it becomes necessary to pull the APU FIRE PULL handle, the APU shutoff valve will close.

b. **APU Boost Pump.** The electrically-driven APU boost pump is energized when the APU switch is at the START or RUN position. The pump will continue to run until the APU is shut down. The pump delivers fuel to the APU integral fuel shutoff valve. Pulling the APU FIRE PULL handle will stop the pump.

2-49. Nitrogen Inerting Unit (NIU).

The NIU reduces fire hazards associated with fuel cell ullages (air space) by filling the ullage with oxygen-depleted air. The NIU is self-contained and automatically operated whenever pressurized air and 115 vac power is available. A GO/NO GO press-to-test monitor is located in the aft avionics bay. The NIU utilizes pressurized air from the pressurized air manifold and purges about 70% of the oxygen present. This air is then regulated into the aft fuel cell and onward into the forward fuel cell.

2-50. Electrical Power Sources.

Electrical power for the fuel system is controlled by the following circuit breakers (figure 2-32):

a. The refuel panel receives 24 vdc power directly from the battery through the FUEL FILL circuit breaker on the pilot overhead circuit breaker panel.

b. All fuel system gages and caution/warning lights (except those on the refueling panel and the pilot EXT EMP caution light), receive 28 vdc emergency bus power by way of the ENG INST circuit breakers on the CPG main circuit breaker panel and pilot overhead circuit breaker panel.

c. Circuits controlled from the pilot and CPG FUEL control panels receive 28 vdc essential bus power by way of the FUEL BST, FUEL TRANS, and FUEL XFEED circuit breakers on the pilot overhead circuit breaker panel.

d. The EXT EMP light on the pilot caution/warning panel receives 28 vdc essential bus power by way of the FUEL TRANS circuit breaker on the pilot overhead circuit breaker panel.

e. Fuel supply system components, automatically controlled by the APU control switch (figure 2-11), receive 28 vdc power by way of the FUEL BST and APU START circuit breakers on the pilot overhead circuit breaker panel and the APU circuit breaker in the aft avionics bay.

f. Fuel supply system components, automatically controlled by the automatic-engine start circuits, receive 28 vdc power by way of the ENG START circuit breaker on the pilot overhead circuit breaker panel.

g. The JETT circuit breaker on the pilot overhead circuit breaker panel controls 28 vdc essential bus power for auxiliary tank jettisons.

Section V. FLIGHT CONTROLS AND AUTOMATIC STABILIZATION EQUIPMENT

2-51. FLIGHT CONTROL SYSTEM.

The flight control system consists of mechanical flight controls, digital automatic stabilization equipment (DASE), and an automatically or manually controlled stabilator. The mechanical flight controls provide a cyclic stick, collective stick, and directional pedals in each crew station, connected in tandem, to provide control inputs to the main and tail rotor hydraulic servo actuators. A mixing unit combines inputs from the servo actuators and transmits them to a non-rotating swashplate. The swashplate changes the linear motion from the mixer unit to rotating motion. The swashplate provides pitch changes for the four main rotor blades. Pedal inputs are transmitted in a similar manner to the tail rotor blades, except the mixer unit is not required. A detailed description of the rotor system design and operation is in Section VIII.

2-52. Cyclic Sticks.

The cyclic sticks, one in each crew station, provide for helicopter movement about the pitch and roll axes. The CPG stick has a lockpin release mechanism at the base of the stick. This allows the CPG to fold the stick down while viewing the heads-down display and provides greater ease for ingress/egress. The cyclic stick remains functional in this position and is returned to the extended position by pulling aft on a lever in front of the stick grip. Both cyclic stick grips (figure 2-22) have switches for weapons firing, DASE disengagement, trim feel, radio and intercommunications, and flight mode symbology. The pilot's grip also has a remote transmitter selector switch for radio selection. These switches will be discussed in more detail with their associated systems.

CAUTION

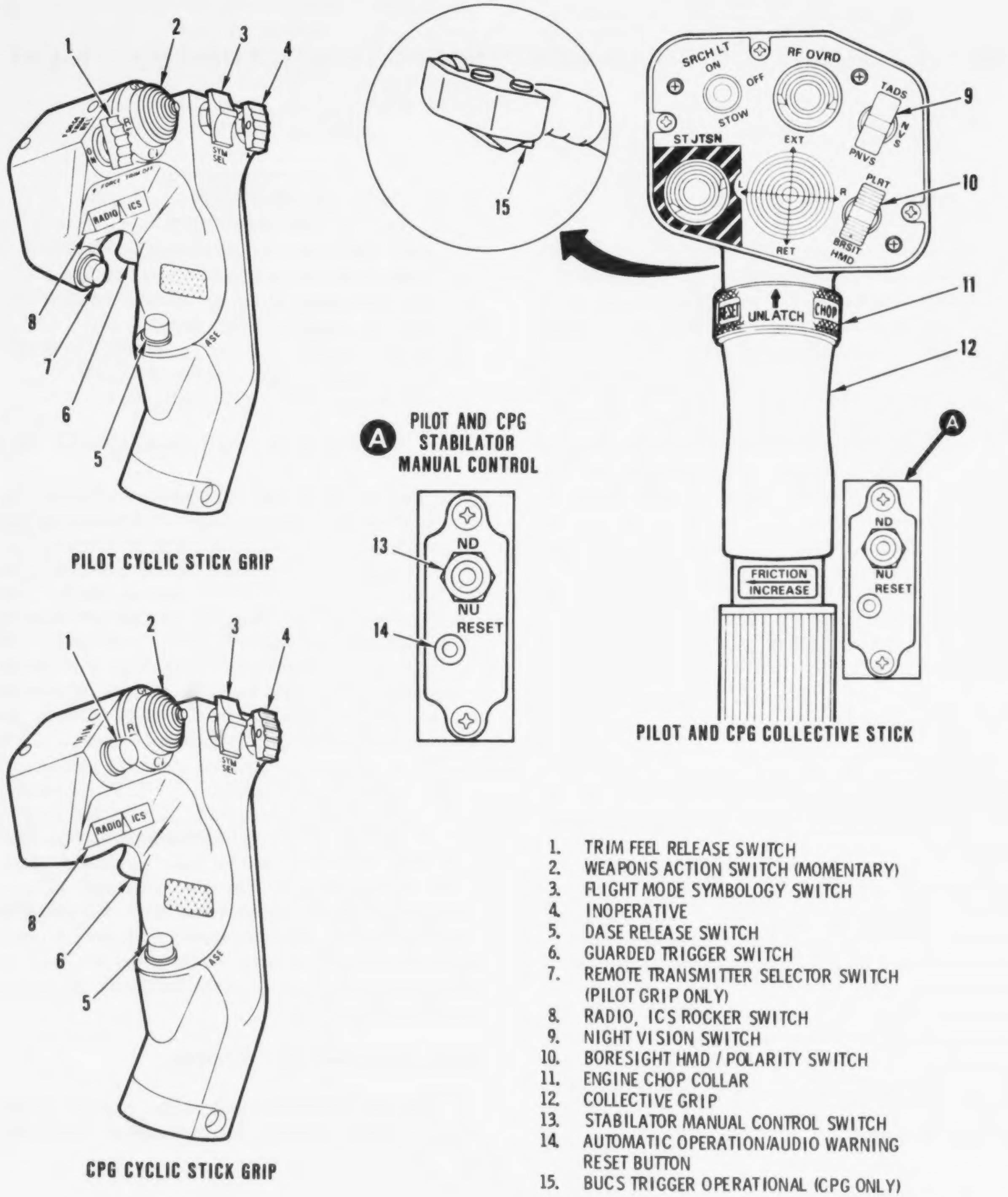
Care shall be exercised in extending or folding down the CPG cyclic stick when the rotors are turning. Cyclic control system inputs may occur. It is recommended that the pilot hold his cyclic stick steady while the CPG is extending or folding his cyclic stick.

2-53. Collective Sticks.

The collective sticks in both crew stations (figure 2-22) provide the crew with a means of adjusting pitch angle of the main rotor blades and fuel flow metering requirements of the gas generator turbine. Each collective stick has an engine chop collar just aft of the collective stick switch box (for operation, see Section III) to permit both engines to be reduced to idle without moving the power levers. A switch panel at the end of each collective stick contains a searchlight (SRCH LT) switch, an extend-retract (EXT-RET) momentary searchlight switch, a wing stores jettison guarded button (ST JTSN), a NVS switch, a BRSIT HMD/PLRT switch, and a radio frequency override (RF OVRD) switch. The RF OVRD switch is nonfunctional. The Pilot and CPG collective sticks have a BUCS select switch; the pilot's BUCS select switch is nonfunctional. These switches will be discussed in more detail with their associated systems. A twist-type friction adjustment is installed on the collective assembly to prevent the collective stick from creeping during flight.

2-54. Directional Control Pedals.

The directional control pedals, one set in each crew station, provide for helicopter movement


1
2
3
4
5
6
7
8
SYM SEL
RADIO
ICS
ASE
TRIM
R
15
SRCH LT
ON
OFF
STOW
RF OVRD
TADS
NVS
PNVS
ST JTSN
EXT
L
R
RET
PLRT
BRSIT HMD
9
10
RESET
UNLATCH
CHOP
11
12
FRICTION INCREASE
A
ND
NU
RESET
13
14

PILOT CYCLIC STICK GRIP

CPG CYCLIC STICK GRIP

A PILOT AND CPG STABILATOR MANUAL CONTROL

PILOT AND CPG COLLECTIVE STICK

1. TRIM FEEL RELEASE SWITCH
2. WEAPONS ACTION SWITCH (MOMENTARY)
3. FLIGHT MODE SYMBOLOGY SWITCH
4. INOPERATIVE
5. DASE RELEASE SWITCH
6. GUARDED TRIGGER SWITCH
7. REMOTE TRANSMITTER SELECTOR SWITCH (PILOT GRIP ONLY)
8. RADIO, ICS ROCKER SWITCH
9. NIGHT VISION SWITCH
10. BORESIGHT HMD / POLARITY SWITCH
11. ENGINE CHOP COLLAR
12. COLLECTIVE GRIP
13. STABILATOR MANUAL CONTROL SWITCH
14. AUTOMATIC OPERATION/AUDIO WARNING RESET BUTTON
15. BUCS TRIGGER OPERATIONAL (CPG ONLY)

MM01-014D

Figure 2-22. Cyclic Stick Grips and Collective Stick Control

about the yaw axis. Both sets of pedals are adjusted by applying foot pressure and moving a pedal adjust quick-release lever. Pressing the upper portion of either pedal actuates a master brake cyclinder which delivers hydraulic power to a brake disc at the respective main landing gear wheel. Section I contains descriptions of the main landing gear and brake system.

2-55 Trim Feel.

Either crewman can trim the cyclic and pedal controls. A lateral, longitudinal, and directional trim feel magnetic brake and spring assembly is incorporated into each control system. Setting the pilot's TRIM FEEL switch to the ON position will engage the magnetic brakes in the longitudinal, lateral, and directional flight controls. The spring assemblies will hold the cyclic stick and directional pedals in trim. Movement of the cyclic or directional controls, by either the pilot or CPG, with TRIM FEEL on, will cause the spring assemblies to compress and provide feel to the controls. When control pressure is released, the controls will return to their trimmed position. Retrimming is accomplished by a TRIM REL pushbutton on the CPG cyclic stick grip or by a TRIM REL switch on the pilots cyclic stick grip. Pressing the button or pressing up on the switch releases the magnetic brake and allows the springs to travel to the new control position. Additionally, this action allows the SAS actuators to recenter, if necessary. Releasing the button or switch will then allow the magnetic brake to engage and hold the springs at the new position. The pilot may press the TRIM REL switch to the full down position to disable trim feel entirely.

With the switch in this position, the ATTD/HOVER HOLD and SAS actuator centering capabilities of the DASE are disabled. The capabilities will return when the switch is returned to the center position. The full down position of the pilot's TRIM REL switch may be used MOMENTARILY to unlatch the magnetic latch of the ATTD/HOVER HOLD switch. The DASE capabilities of the pilot's TRIM REL switch remain unaffected in the event of a trim system failure such as with the magnetic brake or spring capsule. DC power is applied to the trim system through the TRIM circuit breaker located on the pilot's overhead circuit breaker panel. Trim feel is operable throughout all ranges of cyclic stick and pedal travel.

CAUTION

With the exception of MOMENTARILY placing the pilot's TRIM REL switch in the full down position to unlatch the ATTD/HOVER HOLD switch, the pilot's TRIM REL switch shall always be in the ON (center) or momentarily in the trim release position (up) for retrimming.

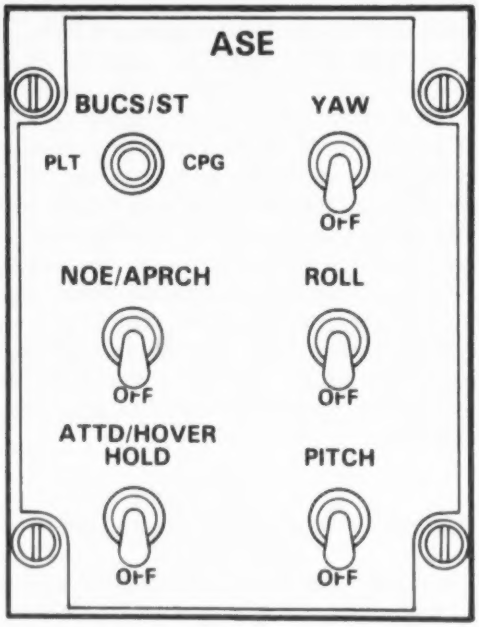
2-56. Flight Control Servos.

The four primary flight control servos are tandem units that use hydraulic pressure from both the primary and utility hydraulic systems. The primary and utility sides of the servos are independent of each other which provides redundancy in the servos. If one hydraulic system fails, the remaining system can drive the flight control servos. If both systems fail simultaneously during flight, either crew member can use stored accumulator hydraulic pressure to provide limited hydraulics for safe landing. Section VI contains a detailed description of the emergency hydraulic system. The primary side of each flight control servo has two electrohydraulic solenoid valves which respond to DASE computer signals for back up controls (BUCS) and stability augmentation.

2-57. Digital Automatic Stabilization Equipment.

The digital automatic stabilization equipment (DASE) augments stability and enhances maneuverability of the helicopter. DASE includes and/or controls the following: stability and command augmentation in pitch, roll, and yaw, attitude hold, heading hold, hover augmentation, turn coordination, and the back up control system (BUCS). Major components include an ASE panel, a DASE computer eight-control position transducer (LVDT), two 26 vac transformers, and four hydraulic servo actuators. The ASE control panel (fig. 2-23), located in the pilot left console, has five magnetic switches and a BUCS/ST switch.

a. **Automatic Stabilization.** The DASE has both a stability augmentation system (SAS) and a command augmentation system (CAS). The SAS reduces crew workload by dampening airframe movement caused by external forces such as in air turbulence and weapons recoil. The CAS augments helicopter response by mechanical control inputs and commands to the longitudinal (pitch), lateral (roll), and directional (yaw), flight control servo actuators. CAS signals are generated by movement of crew station flight controls which are sent to the DASE computer. The DASE computer sums the SAS/CAS information with inputs from the heading and attitude reference set (HARS) and the air data sensor system (ADSS). The DASE computer provides positioning commands to a two-stage electrohydraulic SAS servo valve on the primary side of the longitudinal, lateral, and directional flight control servo actuators.



MM01-113D

Figure 2-23. Pilot ASE Control Panel

Positioning of the SAS servo valve determines the amount and direction of movement of the SAS actuators. The position of each of the SAS actuators is transmitted to the DASE computer by the LVDT's. The motion of each SAS actuator is summed with the mechanical input to each flight control servo, but the SAS actuator authority is limited to 10% bidirectional motion in all axes except the longitudinal where the authority is 10% aft and 20% forward. The DASE is engaged through the pilot ASE control panel.

On the panel (figure 2-23) are five single-throw, two-position magnetic switches labeled PITCH, ROLL, YAW, and ATTD/HOVER HOLD; the NOE/APPR switch is part of the stabilator system.

The ASE release button at the base of each cyclic stick grip, when depressed, causes all three channel switches to drop to OFF. Control panel 28 vdc is provided through the ASE DC circuit breaker on the pilot overhead circuit breaker panel. The DASE computer automatically disengages a mistrack of more than 35% and lights the ASE FAIL indicator on both caution / warning panels; concurrently, the PITCH, ROLL, and YAW switches on the ASE control panel will drop to OFF. The BUCS/ST switch on the DASE control panel permits the pilot to perform a go-no-go check of the BUCS. A squat switch on the left main landing gear disables the YAW CAS function during ground taxi to prevent overcontrol of the helicopter. The YAW channel circuitry in the DASE computer receives sideslip data from the air data sensor.which provides turn coordination above 60 knots.

b. **Attitude Hold.** A limited authority attitude hold mode is provided in the pitch and roll axes. This provides the pilot with limited hands-off flying capabilities in cruise or holding pattern flight thus allowing him more time to concentrate on other duties. Attitude hold will be functional only if: (1) the ATTD/HOVER HOLD and PITCH and ROLL switches on the ASE panel are engaged; (2) force trim is on, and (3) longitudinal airspeed of the helicopter is 60 knots TAS or greater. The hover augmentation system (HAS) is incorporated with attitude hold. HAS reduces pilot workload during hover and low-speed flight. The function is provided below 50 knots TAS and 15 knots GS and uses lateral and longitudinal acceleration signals from the HARS. The hover augmentation system requires that the ATTD / HOVER HOLD, PITCH, and ROLL switches on the ASE panel be engaged. Heading hold is switched-in automatically with HAS engagement. Heading hold reduces the pilot's workload in maintaining a desired heading below 50 knots TAS and 15 knots GS. The YAW switch must be ON for heading hold engagement. The heading hold function uses heading reference data from the HARS. The ATTD/ HOVER HOLD switch will automatically disengage when transitioning between modes; attitude hold will disengage at approximately 55 KTAS when decelerating, HAS will disengage when 15 knots ground speed or 50 KTAS is exceeded. The HAS uses the SAS actuator to maintain position and damp external disturbances to the aircraft. The HAS position is initialized by engaging the ATTD/HOVER HOLD switch or utilizing the momentary OFF position of the TRIM REL switch. The position hold feature of the HAS will allow the helicopter to drift from the initialization point as a function of inertial velocity (doppler damped) errors which vary with time. The SAS authority margin will be biased from the centered position as errors build with time.

NOTE

Over time the SAS actuators may reach saturation limit if not centered by reinitializing. The ATTD/HOVER HOLD features in pitch, roll, or yaw will be lost if saturation occurs. The ATTD/ HOVER HOLD feature is a limited hands off feature and the controls should always be monitored carefully.

c. **Backup Control System (BUCS).** The BUCS is a single channel fly-by-wire flight control system that may be engaged in the event of a mechanical control system jam or severance. The BUCS can be engaged on a channel-by-channel basis whenever the DASE computer senses a mechanical control linkage severance or in the event of a jam whenever the pilot breaks the shear pin in the shear pin actuated decoupler (SPAD). There exists specific logic as to which crewmember will have control depending on the location of the severance or jam. The entire BUCS system is undergoing test and is not authorized for use at anytime. The BUCS circuit breaker on the pilot's center circuit breaker panel shall remain out and physically restrained at all times. Upon completion of the testing, the complete description of the BUCS along with the engagement logic and any flight limitations will be added to the Operator's manual.

2-58. STABILATOR SYSTEM.

A variable angle of incidence stabilator is installed to enhance helicopter handling characteristics. The stabilator is designed so that it will automatically be positioned by stabilator control units. These units determine stabilator position from airspeed, pitch rate, and collective stick position inputs. Automatic stabilator range of travel is from 5 degrees trailing edge up through 25 degrees trailing edge down. Manual control is from 10 degrees trailing edge up to 35 degrees trailing edge down. The stabilator is driven by two independent dc motors. Stabilator operation, in either manual or automatic mode, requires both ac and dc power supplies. Associated crew station controls and indicators are as follows:

a. **Circuit Breakers.** Stabilator circuit breakers are installed on the pilot overhead circuit breaker panel. Four circuit breakers labeled STAB AUTO AC and DC and STAB MAN DC and AC.

b. **Stabilator Manual Control Switch.** This switch is located on a stabilator control panel (figure 2-22) installed inboard and forward of the friction grip on each collective stick. The switches, marked NU (Nose up) ND (Nose down), permit the crewmembers to control the stabilator angle of incidence. The manual mode would disengage both the normal auto and NOE/APPR modes below 80 knots. Selection of the manual mode will cause the pilot and CPG MAN STAB lights to illuminate. Transitioning above 80 KTAS in the manual mode will result in automatic switchover to auto mode. Failure of the automatic switchover to auto mode will result in the following:

(1) Pilot and CPG master caution/warning light starts blinking.

(2) Pilot and CPG caution/warning MAN STAB light starts blinking.

(3) Stabilator aural tone comes on.

Below 80 KTAS automatic mode is regained after selection of manual mode by pressing the automatic operation/audio tone RESET button on either collective stick.

c. **NOE/APPR Switch.** This switch positions the stabilator at 25 degrees (trailing edge down) below 80 KTAS. If auto mode is on, this mode is selectable at any speed from a magnetically held switch on the pilot ASE control panel. Transitioning past 80 knots will result in normal stabilator scheduling. Failure to revert to normal stabilator scheduling will result in the following:

(1) NOE/APPR mode select switch OFF.

(2) Pilot and CPG master caution/warning light starts to blink.

(3) Pilot and CPG caution/warning MAN STAB light flashes.

(4) Stabilator aural tone comes on.

Regaining auto mode after the NOE/APPR mode is selected would be accomplished by pressing the momentary automatic operation/audio tone RESET button on the pilot or CPG collective stick or setting the NOE/APPR switch to OFF.

d. **Stabilator Position Indicator.** The STAB POS DEG indicator, located in the upper right section of both instrument panels, provides a visual indication of stabilator angle of incidence in either manual or automatic modes of operation. It is calibrated from 10 degrees trailing edge up to 35 degrees trailing edge down to reflect the position of the stabilator trailing edge. An OFF flag is displayed on the indicator face when the instrument is not operating and DC electrical power is applied to the indicator. With AC/DC power loss both the OFF flag and pointer are not displayed.

e. **Placard.** A placard installed to the right of the position indicator in each crew station lists stabilator incidence angles for given airspeeds.

f. **Master Caution Light.** (Functional only in the automatic mode.) Stabilator malfunctions will be visually noted by illumination of both MASTER CAUTION lights and the MAN STAB segments on both caution/warning panels.

g. **Audio Signals.** Both crewmembers will be audibly alerted to stabilator malfunctions by a constant audio signal. This signal is designed to activate in case of a malfunction in the automatic mode. It may be disabled by depressing the RESET button on the manual control panel.

Section VI. HYDRAULIC AND PRESSURIZED AIR SYSTEMS

2-59. HYDRAULIC SYSTEMS.

Two independent hydraulic systems are installed so that failure of one system will not affect operation of the other. They are designated as the primary and utility hydraulic systems. They are similar but not identical; they have separate, as well as shared functions.

2-60. PRIMARY HYDRAULIC SYSTEM.

The primary hydraulic system (figure 2-24) provides hydraulic power to the primary side of the lateral cyclic, longitudinal cyclic, collective, and directional servoactuators. Only the primary sides of these servoactuators (discussed in more detail in Section V) have electrohydraulic valves that allow the digital automatic stabilization equipment (DASE) and backup control system (BUCS) to affect the flight controls. Consequently, failure of the primary hydraulic system will result in the loss of DASE and BUCS. The primary hydraulic equipment includes the hydraulic pump, manifold, servoactuators and heat exchanger.

2-61. Primary Hydraulic Pump.

The primary hydraulic pump is mounted on the accessory drive case of the main transmission (left side). The pump is of constant-pressure variable-displacement design driven by the transmission accessory gear train.

2-62. Primary Manifold.

The primary manifold is installed on the left forward quadrant of the transmission deck. Its function is to store, filter, supply, and regulate the flow of hydraulic fluid. The manifold reservoir is pressurized on the return side by PAS air acting on the manifold reservoir piston. This prevents pump inlet cavitation. Servicing crews introduce fluid to the reservoir through Ground Support Equipment (GSE) connections or the hand pump. The primary hydraulic system fluid capacity is six pints. The reservoir stores about one pint. Section XV contains specifications, capacities, and procedures for oil system servicing. Other provisions within the primary manifold are briefly described below:

a. An air-bleed valve is used to deplete the pressurized air on the manifold for system repair or service.

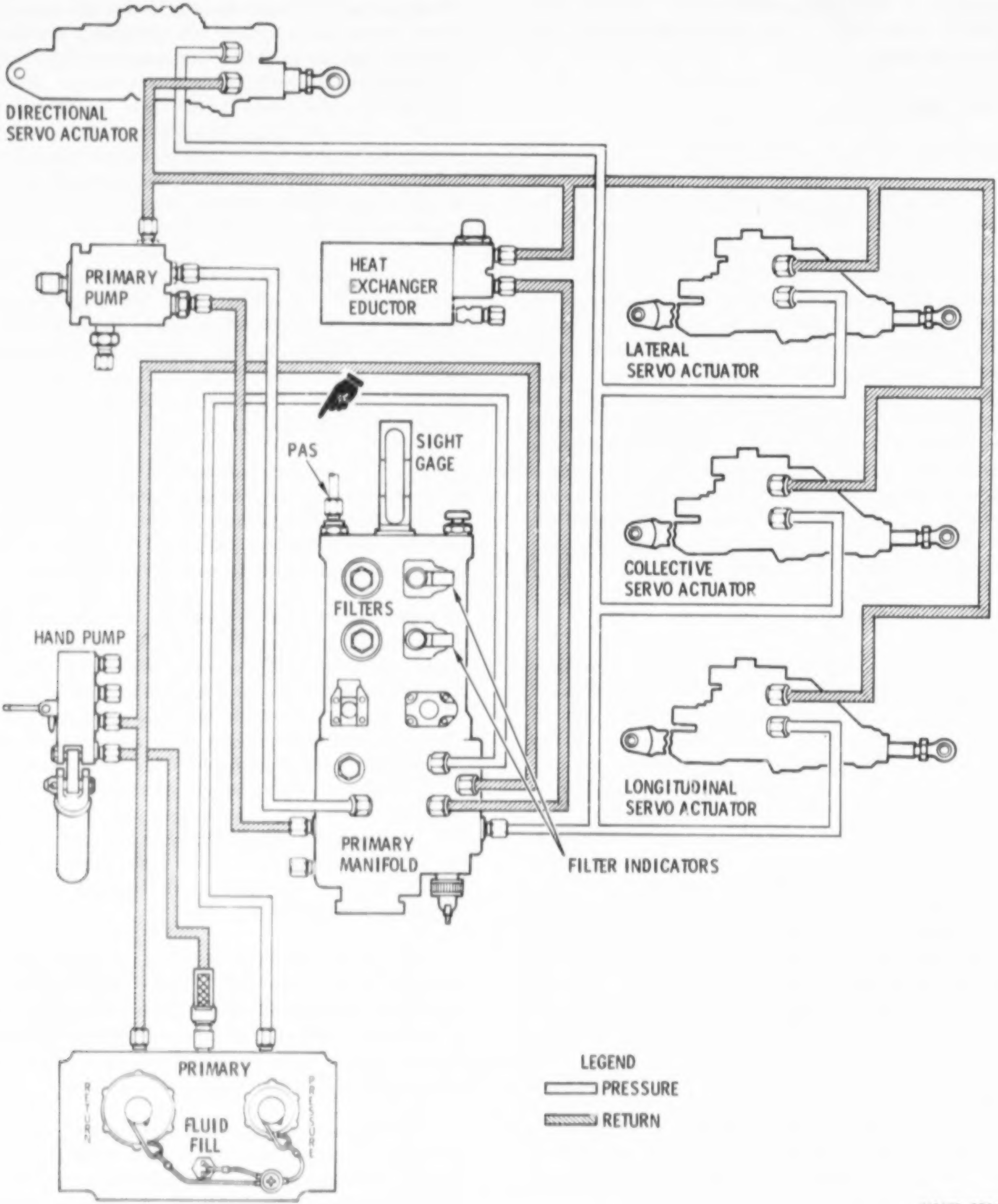
b. High-pressure and low-pressure relief valves regulate fluid pressure from the pump and the return to the manifold.

c. A reservoir low-level indicating switch is activated by the manifold reservoir piston. This illuminates an OIL LOW PRI HYD segment light on the pilot caution/warning panel to indicate minimum operating level.

d. A fluid level indicator in the manifold reservoir housing allows visual inspection of the reservoir oil level.

e. Filters on both manifold pressure and return sides have mechanical impending bypass indicators for visual inspection. These indicators operate on differential pressure. Both impending bypass indicators illuminate the OIL BYP PRI HYD segment on the pilot caution/warning panel. Only the return filter has bypass provisions.

f. A pressure switch senses primary system pressure and informs the pilot and CPG of a low oil pressure condition by illuminating the PRI HYD PSI segment on the pilot caution/warning panel and PRI HYD segment on the CPG panel. This switch illuminates the segments until the system pressure is above 2050 psi and will again illuminate the segments when pressure falls below 1250 psi.


DIRECTIONAL SERVO ACTUATOR
PRIMARY PUMP
HEAT EXCHANGER EDUCTOR
LATERAL SERVO ACTUATOR
PAS
SIGHT GAGE
FILTERS
COLLECTIVE SERVO ACTUATOR
HAND PUMP
LONGITUDINAL SERVO ACTUATOR
PRIMARY MANIFOLD
FILTER INDICATORS
PRIMARY
RETURN
FLUID FILL
PRESSURE
LEGEND
PRESSURE
RETURN

MM01-090B

Figure 2-24. Primary Hydraulic System

g. A pressure transducer measures hydraulic pressure on the pressure side of the manifold and transmits this value to the left side of the pilot dual hydraulic gage.

2-63. Deleted.

2-64. UTILITY HYDRAULIC SYSTEM.

The utility hydraulic system (figure 2-25) provides hydraulic power to the utility side of the lateral cyclic, longitudinal cyclic, collective, and directional servo actuators. This system also provides hydraulic power to the rotor brake, area weapon, external stores, tail-wheel lock, ammo carrier drive, and APU starter. The utility hydraulic pump (on the accessory drive case of the main transmission right side) and heat exchanger (aft and right of the transmission) are identical to those in the primary system. The only significant difference in the two systems is the manifold. Additional components in the system are the accumulator, rotor brake, and the utility hydraulic return accumulator that dampens hydraulic pressure surges caused by sudden actuation of the gun turret.

2-65. Utility Manifold.

The utility manifold (figure 2-26) is installed on the aft main fuselage deck on the right side. It stores, filters, supplies, and regulates the flow of utility hydraulic fluid. Demands on the utility system are much greater than those on the primary system, and the utility manifold installation is therefore larger, with a reservoir capacity of 1.3 gallons. Total system capacity is about 2.6 gallons. An air-pressure relief valve, low-pressure relief valve, high-pressure relief valve, reservoir low-level indicating switch, fluid-level indicator, return filter, pressure filter, pressure switch, and pressure transducer, are identical in function to the primary system components (paragraph 2-62). The pilot caution/warning panel provisions are also similar; but the lights are labelled OIL LOW UTIL HYD, OIL BYP UTIL HYD, and UTL HYD PSI. Low utility hydraulic pressure also illuminates the CPG UTIL HYD light. The utility manifold also incorporates several other features not duplicated on the primary manifold. These are the utility accumulator hydraulic pressure transducer and rotor brake solenoids.

a. The low-level and auxiliary isolation valves permit hydraulic fluid to flow to the external stores, ammo carrier drive, tail wheel lock actuator, and area weapon turret. If the reservoir fluid level decreases significantly, the reservoir piston, driven by PAS air, will contact and close the low-level valve. The auxiliary isolation valve, which normally requires two sources of pressure to permit fluid flow, will then close and deny hydraulic power to the area weapon turret, the external stores actuators, and the ammo carrier drive.

b. A shutoff valve in the pressure line to the directional servo and TAIL WHL unlock actuator is actuated by the low-level switch in the utility system reservoir. The utility side of the directional servo actuator and the TAIL WHL unlock actuator will be inoperative if a low utility system fluid level is sensed.

c. The accumulator isolation valve normally isolates accumulator pressure from the rest of the utility system but allows system flow from the pump to pass through a portion of the valve and on to the utility side of the tandem servo actuators.

d. An override solenoid valve, normally de-energized closed, permits crew management of the accumulator reserve pressure. When the pilot or copilot/gunner places his EMER HYD switch in the ON position, the override solenoid valve will energize open and accumulator fluid will pass to the accumulator isolation valve via emergency routing. In this case, another portion of the accumulator isolation valve will permit accumulator fluid to flow to the utility side of the servo actuators. The EMER HYD switch is powered through the EMERG HYD circuit breaker on the pilot overhead circuit breaker panel.

e. An accumulator hydraulic pressure transducer in the manifold will provide the pilot with a continual indication of accumulator pressure on the accumulator hydraulic pressure indicator. During normal operation, the indicated pressure will be the same as that of the utility hydraulic system.

f. The rotor brake solenoid valves are controlled by a three-position switch (OFF-BRAKE LOCK) on the pilot power lever quadrant adjacent to the power levers (figure 2-17). When the switch

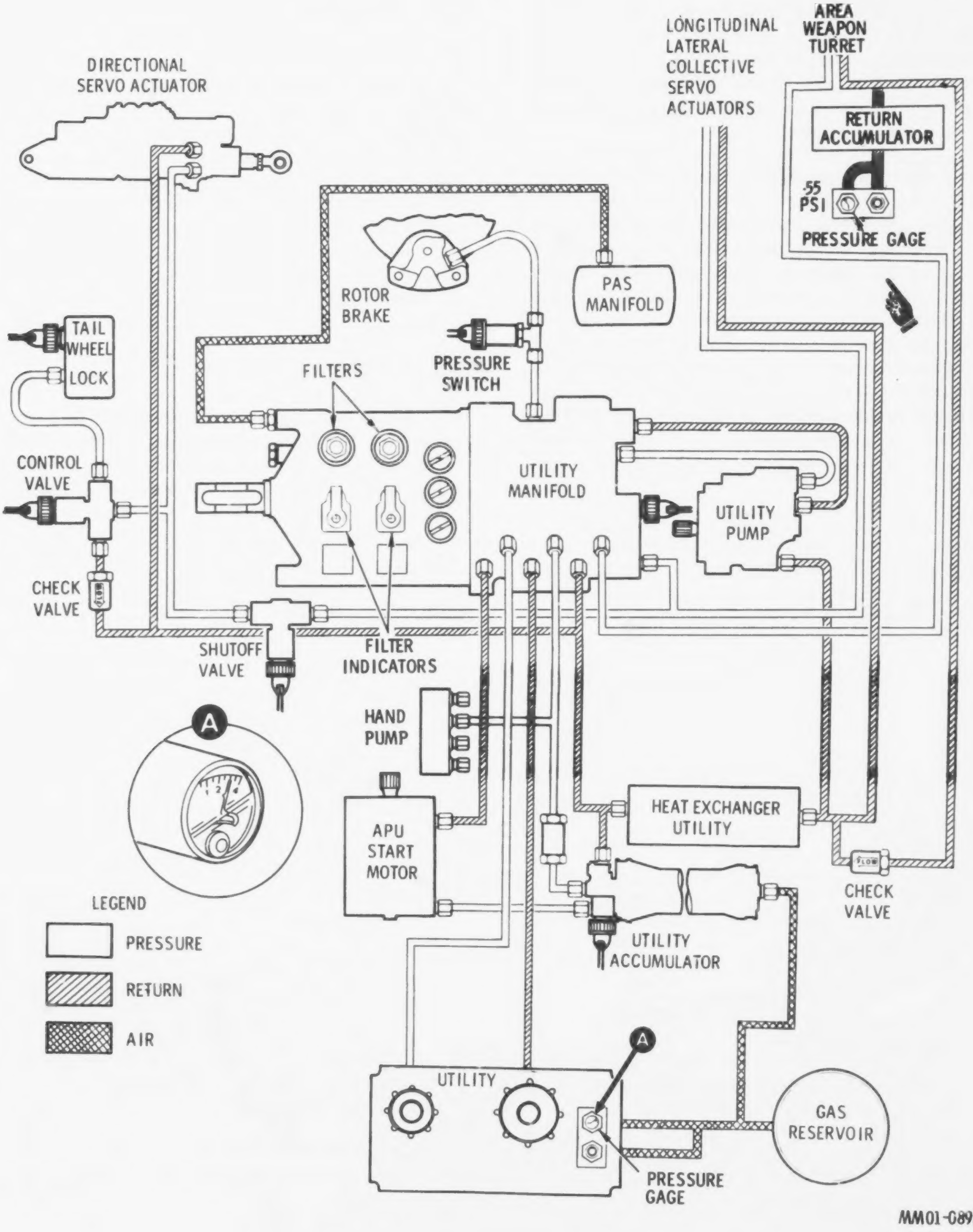

DIRECTIONAL
SERVO ACTUATOR
LONGITUDINAL
LATERAL
COLLECTIVE
SERVO
ACTUATORS
AREA
WEAPON
TURRET
RETURN
ACCUMULATOR
55
PSI
PRESSURE GAGE
ROTOR
BRAKE
PAS
MANIFOLD
TAIL
WHEEL
LOCK
FILTERS
PRESSURE
SWITCH
UTILITY
MANIFOLD
UTILITY
PUMP
CONTROL
VALVE
CHECK
VALVE
SHUTOFF
VALVE
FILTER
INDICATORS
HAND
PUMP
A
APU
START
MOTOR
HEAT EXCHANGER
UTILITY
CHECK
VALVE
UTILITY
ACCUMULATOR
LEGEND
PRESSURE
RETURN
AIR
A
UTILITY
GAS
RESERVOIR
PRESSURE
GAGE
MM01-089D

Figure 2-25. Utility Hydraulic System

is positioned to BRAKE, utility system pressure regulated to 337 psi is applied to stop the rotor brake disc on the main transmission. When positioned to LOCK, the brake OFF solenoid valve traps 3000 psi pressure between the manifold and the rotor brake actuator.

2-66. Utility Accumulator.

The accumulator is a multi-purpose installation unique to the utility hydraulic system. It is located on the right side of the helicopter directly beneath the APU. It stores hydraulic fluid at 3000 psi. The accumulator is charged by nitrogen gas. A gas storage tank supplies the charge and is serviced through a charging port (figure 2-26) on the utility hydraulic service panel. The accumulator provides hydraulic power for rotor brake application, APU starting, and emergency use of flight control operation discussed in paragraphs 2-65d. and 2-65e. above.

2-67. Hand Pump.

A hand pump is installed next to the primary system GSE panel on the right side of the helicopter. The pump provides one method of charging the fluid pressure in the utility accumulator as well as a method for the ground crew to fill both the primary and utility reservoirs. A lever may be moved to any of three positions. This, in turn, will open one of three mechanically operated check valves to the accumulator or to either reservoir. Section XV contains servicing instructions.

2-68. PRESSURIZED AIR SYSTEM.

The pressurized air system (PAS) cleans, pressurizes, regulates, and distributes air to the air turbine starters, fuel boost pump, fuel transfer pump, external fuel tanks, hydraulic reservoirs,

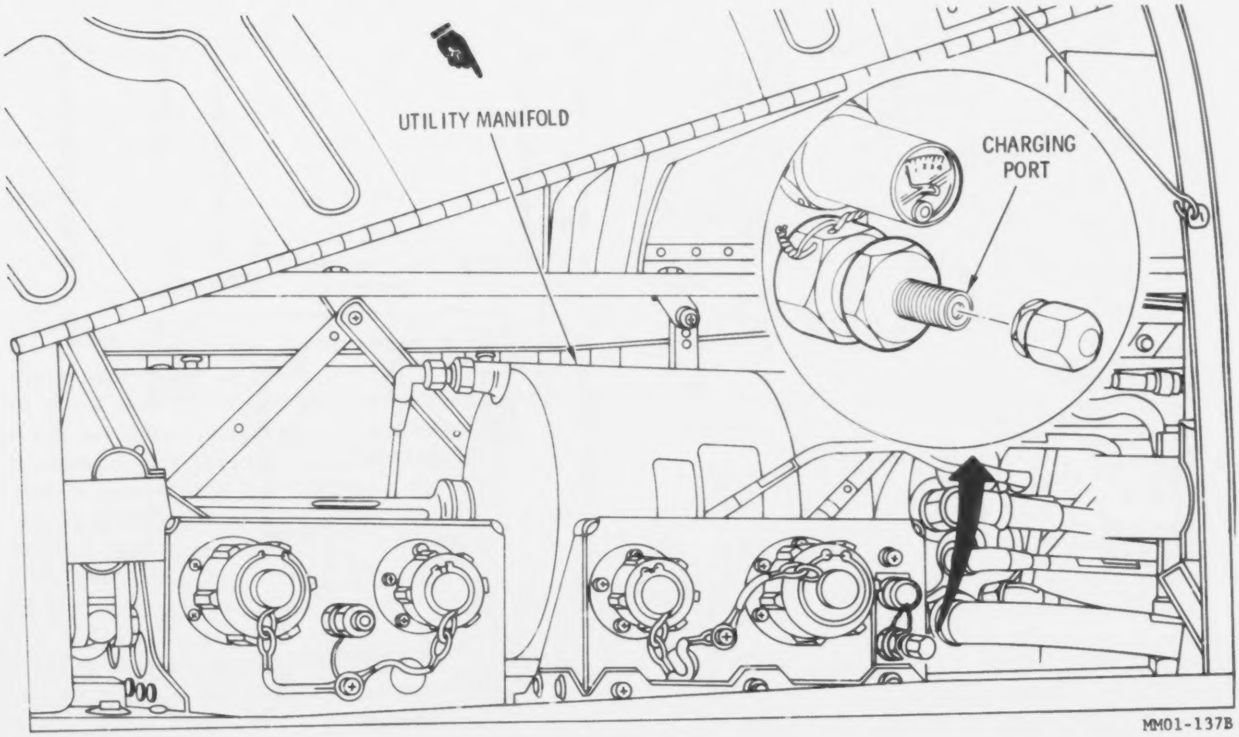


Figure 2-26. Utility Manifold

heat exchangers, defog nozzles, engine cooling louver actuators, utility receptacle, and environmental control unit (ENCU). The pressurized air system has three sources of air: The primary source is the shaft driven compressor; the other sources are bleed air from the No. 1 engine and air from an external air source.

2-69. Shaft Driven Compressor.

The shaft driven compressor (SDC) is mounted on the main transmission accessory case. It uses outside air. The air passes through a particle separator and then through a butterfly-type throttle valve. This valve is closed by a time-delay solenoid when the APU START switch is engaged. The valve remains closed for 60 seconds after the APU START switch is released. This reduces APU loads during starting. The shaft driven compressor will compress air at 3:1 ratio and route it through a surge valve. This valve, mounted on top of the SDC, will open or close as necessary to keep SDC air pressure constant with variable system demand. Pressurized air then passes through a spring-operated check valve and into the PAS manifold. This check valve prevents pressurized air, from sources other than the SDC, from reverse routing back to the SDC. The SDC is lubricated by the main transmission accessory oil pump and has its own scavenge. If the SDC oil temperature exceeds 182°C (360°F), or if the SDC fails, the pilot SHAFT DRIVEN COMP caution light illuminates.

2-70. No. 1 Engine Bleed Air.

The No. 1 engine provides an alternative source of pressurized air in case of SDC failure. The engine compressor bleed air selector valve opens automatically if SDC output falls below 10 psi. Simultaneously, a spring-operated check valve opens. When closed, this valve prevents pressurized air from going to the engine compressor when the SDC is operating. Each engine provides bleed air to its engine inlet to prevent ice formation and to keep the engine cooling louvers closed while the engines are operating. The bleed air used in these last two instances is independent of the pressurized air system.

2-71. External Air Source Receptacles.

The receptacle for external air source connection (figure 2-40) is on the lower portion of No.1 engine nacelle. When the air source is connected and operating, a normally closed check valve to the pressurized air system opens to allow air to pressurize the manifold.

Section VII. POWER TRAIN

2-72. POWER TRAIN.

The power train (figure 2-27) transmits engine power to the rotors and transmission-mounted accessories. The power train includes two engine nose gearboxes, two shafts to the main transmission, the main transmission, main rotor drive shaft, tail rotor drive shafts, intermediate gearbox, tail rotor gearbox and APU drive shaft, and couplings.

2-73. MAIN ROTOR DRIVE SYSTEM.

The main rotor drive system consists of the engine nose gearboxes, two input drive shafts, main transmission, accessory drives, and main rotor drive shaft.

2.74. Engine Nose Gearboxes.

The engine nose gearboxes are mounted on the nose of each engine. They reduce nominal engine speed and change the angle of drive. Both nose gearboxes have self-contained pressurized oil systems with provisions to ensure limited operation if a total loss of pressurized lubrication occurs. These self-contained systems feature a pressure pump driven by the gearbox output shaft, filter with impending bypass filter indicator and filter bypass capability, high-pressure relief valve, and sump. Mounted on the nose gearbox output drive is an axial-type fan that draws air through the gearbox fairing and past cooling fins on the gearbox. The input drive shafts have flexible couplings that require no lubrication. Externally accessible accessories include a filler, breather, oil level sight gage, chip detector/temperature sensor with fuzz suppressor to burn off minor particles of metal, pressure transducer, and temperature probe.

2-75. Engine Nose Gearbox Caution Light Provisions

High oil temperature, low oil pressure, and the presence of chips are detected in each gearbox. The pilot is alerted to the condition by six caution segments: OIL HOT NOSE GRBX 1, OIL HOT NOSE GRBX 2, OIL PSI NOSE GRBX 1, OIL PSI NOSE GRBX 2, CHIPS NOSE GRBX 1, and CHIPS NOSE GRBX 2. Either the ENG 1 or ENG 2 segment will simultaneously illuminate on the CPG caution/warning panel (figure 2-38).

2-76. Main Transmission.

The main transmission combines the two engine nose gearbox inputs and provides drive to the main rotor, tail rotor, accessories, and rotor brake disc. Two overrunning clutches at the main transmission permit either engine to be disengaged from the transmission during single-engine operation or both engines during autorotation. The main transmission reduces the rpm input to the main rotor, tail rotor, and the rotor brake disc. The main transmission is mounted below the main rotor static mast base which allows its removal without removing the upper controls, mast, hub, or blades. The main rotor drive shaft is designed to carry torque loads only. The rotor hub is on a static mast which carries vertical and bending loads. The drive shaft rotates inside the static mast. The main transmission has primary and accessory drive trains. The primary drive train, through three stages, changes the angle and speed of the power drives to the main rotor, tail rotor, and rotor brake. Overrunning clutches allow the APU to drive the transmission accessory gearbox when the engines are not operating. The transmission accessories consist of two alternating-current generators, two hydraulic pumps, and a shaft driven compressor. A magnetic pickup measures main rotor rpm.

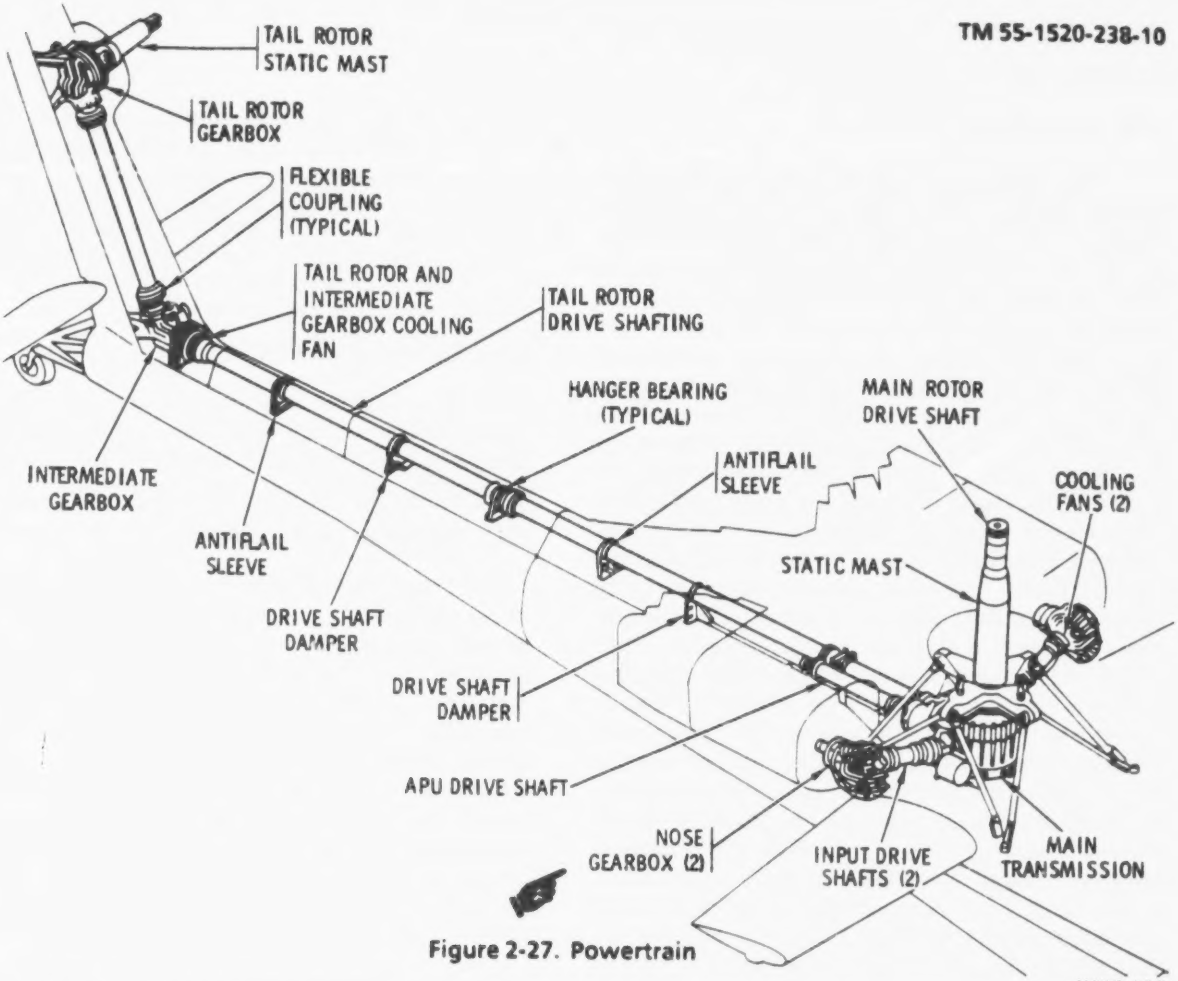

TAIL ROTOR STATIC MAST
TAIL ROTOR GEARBOX
FLEXIBLE COUPLING (TYPICAL)
TAIL ROTOR AND INTERMEDIATE GEARBOX COOLING FAN
TAIL ROTOR DRIVE SHAFTING
INTERMEDIATE GEARBOX
HANGER BEARING (TYPICAL)
MAIN ROTOR DRIVE SHAFT
ANTIFLAIL SLEEVE
COOLING FANS (2)
ANTIFLAIL SLEEVE
STATIC MAST
DRIVE SHAFT DAMPER
DRIVE SHAFT DAMPER
APU DRIVE SHAFT
NOSE GEARBOX (2)
INPUT DRIVE SHAFTS (2)
MAIN TRANSMISSION
MM01-020D

Figure 2-27. Powertrain

2-77. Main Transmission Lubrication.

The main transmission has two independent oil systems. Each system has its own sump, pump, filter and heat exchanger. Oil level sight gages are located in the transmission housing at each oil sump. These systems are not totally independent in the usual sense because during normal operation, the oils will mix. If oil loss occurs in either sump or in either heat exchanger, the diverter (float) valve will seal off that sump to prevent a total loss of oil. There are provisions throughout the transmission so that even with a total loss of oil there will be limited lubrication. Each oil filter has a bypass capability and an impending bypass filter indicator. Each sump has a fuzz-suppressor-type chip detector and temperature probe. Pressure is measured downstream of each heat exchanger. Oil passing through the heat exchangers, mounted inboard on each engine firewall, is air cooled. The heat exchangers have thermal bypass provisions for cold starts. A third oil pump, driven by the accessory drive, lubricates the accessory gears during APU operation. This pump draws oil from the right oil system sump.

2-78. Main Transmission Caution Lights.

Sensors in the transmission sense adverse conditions which are displayed as caution lights (figure 2-38) in the crew stations. The pilot station has six caution lights: OIL PSI MAIN XMSN 1, OIL PSI MAIN XMSN 2, OIL HOT MAIN XMSN 1, OIL HOT MAIN XMSN 2, CHIPS MAIN XMSN, and OIL PSI ACC PUMP. Activation of any of these lights, except the OIL PSI ACC PUMP, simultaneously illuminates either MAIN XMSN 1, MAIN XMSN 2, or CHIPS MAIN XMSN on the copilot/gunner caution/warning panel.

2-79. Rotor Brake.

The rotor brake reduces turnaround time for aircraft loading and servicing and prevents windmilling of the rotor system during gusty wind conditions. The rotor brake disc is visible at the aft end of the transmission. When set at LOCK with full utility hydraulic system pressure, the brake prevents the gas turbines from driving the power turbines when both engines are at idle. The rotor brake is controlled by the RTR BK switch on the pilot power lever quadrant (figure 2-17). The switch has three positions: OFF, BRAKE, and LOCK. A system of interlocks prevents the rotor brake from being locked when the power levers are in any position except IDLE and OFF. When the switch is set at BRAKE, solenoid valves in the utility hydraulic manifold operate to actuate the brake. When the rotor is stopped, the switch may be set at LOCK which causes solenoid valves in the manifold to deenergize and all available utility hydraulic pressure to the brake is 30 psi from the pressurized air system which, when operating, pressurizes the return side of the utility hydraulic system. Rotor brake electrical solenoids and the pressure switch receive power by way of the RTR BRK circuit breaker on the pilot overhead circuit breaker panel. If this circuit breaker is open, or if helicopter emergency electrical power is lost for any reason, the rotor brake, if previously set at LOCK, will remain locked as long as accumulator pressure is available.

CAUTION

With rotors turning, do not place the RTR BK switch in LOCK position.

NOTE

- When engaging rotor lock, pause in the BRAKE position until the RTR BK caution light has illuminated prior to placing the switch in the lock position. The power levers will not advance past the ground idle detent with the rotor brake switch in the LOCK position.
- When operating engines with the rotor brake locked, monitor the main transmission temperature. If the transmission temperature reaches 130°C (266°F), secure operation, or release the rotor brake and turn the rotors until transmission temperature returns to normal.

2-80. TAIL ROTOR DRIVE SYSTEM.

The tail rotor drive system consists of the tail rotor drive shafting, couplings, forward and aft hanger bearings, dampers, antiflail assemblies, and intermediate and tail rotor gearboxes.

2-81. Tail Rotor Drive Shafting.

There are four tail rotor drive shaft sections. Three tail rotor drive shafts lead from the transmission to the intermediate gearbox. Two are of equal length. The shaft is installed on the vertical stabilizer between the intermediate and tail rotor gearboxes. Hanger bearings support the longer shafts. They are covered by aerodynamic fairings which may be opened for maintenance and inspection. The two equal-length shafts incorporate friction dampers and antiflails. Flexible couplings, attached to the shaft ends, are capable of accommodating shaft misalignments throughout the power range.

2-82. Intermediate Gearbox.

CAUTION

Prolonged out of ground effect hovering (20-30 min.) with outside air temperatures above 75°F (24°C) may cause the intermediate gearbox to overheat.

The intermediate gearbox, at the base of the vertical stabilizer, reduces the rpm and changes the angle of drive. A fan mounted on the gearbox input shaft draws air from an inlet on the vertical stabilizer. This air cools both the tail rotor gearbox and the intermediate gearbox. Four thermistors monitor temperature and an accelerometer measures vibration limits. The intermediate gearbox is a grease-lubricated sealed unit.

2-83. Intermediate Gearbox Caution Light Indicators.

The four thermistors and the accelerometer provide crew members with temperature and vibration caution lights. Both crew stations have TEMP INT and VIB GRBX light segments.

2-84. Tail Rotor Gearbox.

CAUTION

Prolonged out of ground effect hovering (20-30 min.) with outside air temperatures above 75°F (24°C) may cause the tail rotor gearbox to overheat.

The tail rotor gearbox, mounted on the vertical stabilizer, reduces the output rpm and changes the angle of drive. The tail rotor output shaft passes through the gearbox static mast. All tail rotor loads are transmitted to the static mast. The output shaft transmits only torque to the tail rotor. Lubrication of this gearbox is identical to that of the intermediate gearbox.

2-85. Tail Rotor Gearbox Caution Light Indicators.

The four thermistors and the accelerometer function in the same way as for the intermediate gearbox. The associated caution light on the pilot and CPG caution/warning panels are labeled TEMP TR and VIB GRBX. (Both the intermediate and tail rotor gearboxes activate the VIB GRBX light segment).

Section VIII. MAIN AND TAIL ROTOR

2-86. ROTOR SYSTEM.

The rotor system consists of a single, four-bladed, fully articulated main rotor and a four-bladed tail rotor assembly with two teetering rotor hubs.

2-87. MAIN ROTOR.

The main rotor has four blades. The head is a fully articulated system that allows the four blades to flap, feather, lead, or lag independent of one another. The head consists of a hub assembly, pitch housings, rotor dampers, and lead-lag links. Attached to the rotor head are four easily removable blades. The main rotor is controlled by the cyclic and collective sticks through a swashplate mounted about the static mast. Section V describes the main rotor flight control system.

2-88. Hub Assembly.

The main rotor hub is a steel and aluminum assembly that supports the main rotor blades; it is driven by the main rotor drive shaft. The hub rotates about a static mast, which supports it. This arrangement allows the static mast, rather than the main rotor drive shaft, to assume all flight loads. The hub is splined to the main rotor drive shaft by means of a drive plate adapter that is bolted to the hub. The hub is secured to the static mast by a large locknut secured by multiple bolts. The hub houses two sets of tapered roller bearings that are grease-lubricated and sealed. These bearings transfer hub loads to the static mast. Mechanical droop stops limit blade droop. When blade droop occurs, a striker plate on the pitch housing contacts a roller. The roller presses a plunger against a droop stop ring on the lower portion of the hub.

2-89. Pitch Housing.

The pitch housing permits blade pitch changes in response to flight control movements transmitted through the swashplate. This is made possible within the four pitch housings by V-shaped stainless steel strap assemblies that are able to twist and flap to permit blade feathering and flapping. Cyclic and collective stick inputs are transmitted to the pitch housing horns by pitch links attached to the swashplate. Feather bearings are installed inboard on the pitch housing to allow vertical and horizontal loads to be transferred from the pitch housing to the hub. Centrifugal loads are transmitted by each strap assembly to the hub.

2-90. Lead-Lag Links.

The lead-lag link for each blade is connected to the outboard end of each pitch housing and is secured in place by a pin and two bearings that allow the link to move horizontally. The pin goes through the V-portion of each strap within the pitch housing.

2-91. Damper Assemblies.

Two damper assemblies control the lead-lag movement of each main rotor blade. Each damper attaches outboard to a link lug and inboard to a trunnion at the pitch housing. The damper contains elastomeric elements that distort to allow the blade to lead or lag.

2-92. Main Rotor Blades.

Each main rotor blade is a constant-chord asymmetrical airfoil. The outboard tip is swept aft 20 degrees and tapers to a thinner symmetrical section. The blade has a 21-inch chord. Tip weights are installed within the blade. Chord-wise, the leading-edge and forward half of the blade is a four-cell structural box of stainless steel and fiberglass with a stainless steel spar. The aft half of the blade has fiberglass skin with a nomex honeycomb core and a bendable trailing edge strip to aid in blade tracking. Each blade is secured to its lead-lag link by two blade attachment pins. These pins can be removed without the use of tools and they pass vertically through the lead-lag link and blade root fittings which are both made of titanium. Five sets of stainless steel doublers are located on the upper and lower surfaces of the blade at the blade root. The blades may be folded by removing the appropriate blade attachment pin (one for each blade) and any two adjacent pitch link bolts and pivoting the blade to rear position using a hand-held blade support device.

2-93. TAIL ROTOR.

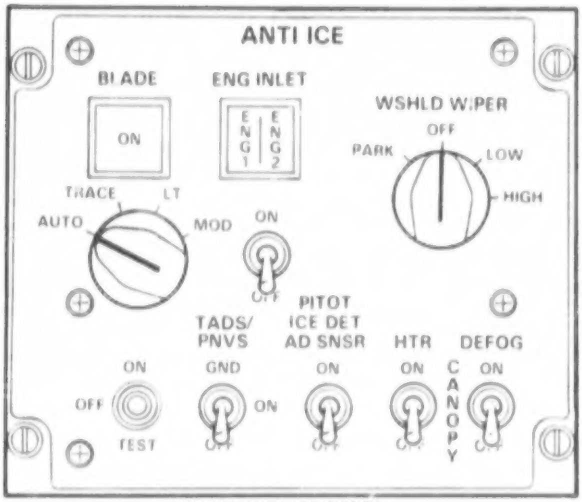
The tail rotor system is of semirigid, teetering design. Two pairs of blades, each pair fastened to its own delta hinged hub, provide antitorque action and directional control. A titanium fork houses two elastomeric teetering bearings and drives the rotating swashplate through an attached scissors assembly. The tail rotor assembly is splined to, and driven by, the tail rotor gearbox drive shaft which passes through a static mast. Blade pitch changes when directional control inputs cause the non-rotating swashplate to act upon the rotating swashplate. One pitch link for each blade, attached to the rotating swashplate and pitch horn, causes blade movement about two pitch-change bearings in the blade root. Centrifugal forces are carried by stainless steel strap assemblies that attach outboard to the blade root and inboard at the hub center. An elastomeric bearing assembly positions the hub and strap pack in the tail rotor fork. Each blade has one stainless steel spar and two aluminum spars. Doublers and rivets attach the blade to the blade root. Brackets on the root fitting hold chord-wise balance weights. Spanwise balance weights are installed at the tip of each blade in an aluminum tip cap.

Section IX. UTILITY SYSTEM

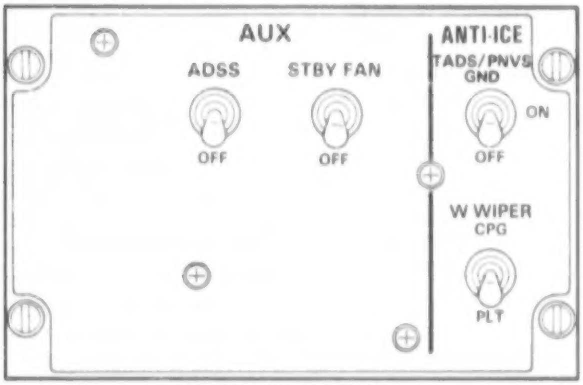
2-94. ANTI-ICING AND DE-ICING.

Multiple anti-icing and de-icing protection is available for the windshields, pitot tubes, air data sensor, pilot night vision sensor (PNVS), target acquisition and designation sight (TADS), engine inlets, nose gearboxes, and main and tail rotor blades. The 30mm weapon and the wing pylons are also susceptible to icing and may be de-iced by periodic flexing in azimuth or elevation. The pilot and CPG have ANTI-ICE panels on their left consoles (figure 2-28).

a. **Windshield.** The two windshields, one in front of, the other directly above the CPG, have built-in transparent anti-ice elements that are heated by 115 vac to prevent ice accumulation. The pilot activates windshield heating by setting a two-position CANOPY HTR toggle switch on his ANTI-ICE panel to ON. In the ON position, the CANOPY HTR switch provides 28 vdc power to turn on the windshield anti-ice control unit. When the control unit is operating, 115 vac from the CANOPY ANTI-ICE circuit breaker is provided to the unit. The 115 vac is controlled by the unit for distribution to the window heater elements. The anti-ice control unit is provided with temperature control and fail-safe features. When there is a failure in the windshield anti-ice system, the control unit will remove 115 vac power from the unit. If the cause for the failure is an overheat or false signal, the unit can be reset by turning the CANOPY HTR switch OFF then back ON. Whenever the control unit fails and the CANOPY HTR switch is in the ON position, the CANOPY ANTI-ICE FAIL light on the pilot caution/warning panel will illuminate.



PILOT ANTI-ICE PANEL



CPG AUX/ANTI-ICE PANEL

MM01-018B

Figure 2-28. Pilot and Copilot/Gunner Anti-Ice Control Panels

b. **Pitot Tube and Air Data Sensor.** The pitot tubes (installed outboard on the leading edge of both wings) and the air data sensor (attached to the top of the main rotor de-ice distributor) are protected from ice accumulation by internal heating elements. The PITOT ICE-DET AD SNSR switch located on the pilot ANTI-ICE panel is a dual function switch. In the ON position, 28 vdc from the EMER BUS through the PITOT HTR circuit breaker is routed to the right wing pitot heater. A second set of contacts on the switch routes ESS DC BUS 3 power, from the AIR DATA DC circuit breaker, to the left wing pitot heater. When energized, the control relay routes ESS AC BUS 1 115 vac, from the AIR DATA AC circuit breaker to the omnidirectional airspeed sensor for anti-icing.

c. **PNVS and TADS Anti-ice/De-ice.** A three-position TADS/PNVS toggle switch on the pilot ANTI-ICE panel controls the operation of the heater. Electrical power input to the TADS/PNVS heater switch is routed from the CANOPY ANTI-ICE CONTR circuit breaker on the pilot overhead circuit breaker panel. When the switch is in the ON position and the helicopter is off the ground, power is routed through the squat switch relay to the TADS/PNVS heater switch. When the helicopter is on the ground, the squat switch opens and power to the TADS/PNVS heater switch is interrupted. When the switch is placed in the GND position, the switch receives power directly from the circuit breaker to heat the PNVS element. A three-position TADS/PNVS toggle switch on the CPG ANTI-ICE panel controls the operation of the heater. Electrical power to the TADS/PNVS switch is provided from the 28 vdc ESS BUS 2, through the canopy ANTI-ICE CONTR circuit breaker on the pilot overhead circuit breaker panel. When the helicopter is in flight, the squat switch relay will provide power to the TADS/PNVS switch ON position. With the helicopter on the ground, the squat switch relay removes power from the TADS/PNVS switch. Power is then provided from the CANOPY ANTI-ICE circuit breaker to the GND position of the switch for ground operation.

d. **Engine Inlet and Nose Gearbox Anti-ice.** Engine bleed air is used to heat the engine air inlet, and heater blankets are used to anti-ice the nose gearbox. Engine anti-ice protection is controlled by a single, two-position ON/OFF ENG INLET toggle switch on the pilot ANTI-ICE panel. In the ON position, ENG 1 and ENG 2 advisory lights above the switch, will illuminate when the system is functioning properly. The engine anti-ice valves and engine gearbox heater blankets receive power from the 115 vac essential bus 2. The input to the system is through the ENG ANTI-ICE circuit breaker on the pilot overhead circuit breaker panel. The ENG INLET ANTI-ICE switch in the OFF position energizes both engine anti-ice valves to the closed position. In the ON position, the ENG INLET ANTI-ICE switch deenergizes the anti-ice valves thus allowing them to open and furnish hot air to the engine inlet for anti-icing. It also energizes the engine gearbox heater blanket controller.

The energized controller allows 115 vac to be supplied through the L NOSE GRBX HTR and R NOSE GRBX HTR circuit breakers on the pilot overhead circuit breaker panel for the nose gearbox heater blankets.

e. **Rotor Blade De-icing System.** The rotor blade de-ice three-position ON, OFF, TEST toggle switch, located on the pilot ANTI-ICE panel, receives 28 vdc from the pilot 28 vdc ESS BUS 3. The input is through the BLADE DEICE CONTR circuit breaker on the pilot overhead circuit breaker panel. In the ON position, the switch will provide 28 vdc power to the main rotor-tail rotor de-icing controller and turn on the controller. When the controller is turned on, it collects data from the signal processor unit, ice detector/rate sensor, and the outside air temperature sensor. If icing conditions prevail, the controller will energize the blade de-ice control relay. The energized blade de-ice control relay provides a ground to the blade de-ice contactor control relay that receives 28 vdc power from ESS BUS 3 through the BLADE DEICE circuit breaker. With the blade de-ice contactor energized, 115 vac, phase A, B, and C is furnished from Gen No. 2 through the blade de-ice contactor to the de-ice controller. (Gen 1 will only furnish power when an overload is sensed on Gen 2, and the contactor is caused to trip). The de-ice controller rectifies the 115 vac current to 268 vdc (+ and −134 vdc) for the rotor blade heaters. The main rotor blades receive + and −134 vdc through slip rings at the main rotor distributor. The main rotor distributor provides a sequential delivery to the blade heater elements. The tail rotor blades receive + and −134 vdc from the de-icing controller through tail rotor slip rings. The tail rotor blade elements and main rotor blade elements are controlled by the de-icing controller by timing the amount of current allowed to the blades for heating. The de-icing controller will also detect faults within the system. When faults occur, the controller shuts off power to the blades and turns on the BLADE ANTI-ICE FAIL light on the pilot caution/warning panel. When the rotor blade de-ice system is turned on the advisory light on the anti-ice panel is turned on. A rotary switch above the ON, OFF, TEST toggle switch provides manual override. When the rotary switch is turned out of the AUTO position it permits manual control to select conditions that provide heating to the rotor blades for (TRACE), light (LT) and moderate (MOD) icing conditions. In the test position, the controller completes one full cycle of the blade anti-ice circuit.

f. **Icing Severity Meter.** An icing severity meter (fig. 2-29) is provided in the right portion of the pilot instrument panel. An aspirated ice detector sensing head, located on the doghouse fairing assembly, provides input signals to a processor. These signals are proportional to liquid water content (LWC). The signals are sent to the icing severity meter to give the pilot a numerical indication of intensity. The meter is marked with both intensities and categories of ice accumulation. A press-to-test switch is provided adjacent to the meter. When pressed, the meter pointer will move to 1.5. Both the BLADE deice and the PITOT AD SNSR switches on the pilot's anti-ice panel (figure 2-28) must be on for the ice detect/rate sensor to operate properly. Electrical power for the deice controller and probe vibrator mechanism is provided through the BLADE deice switch.

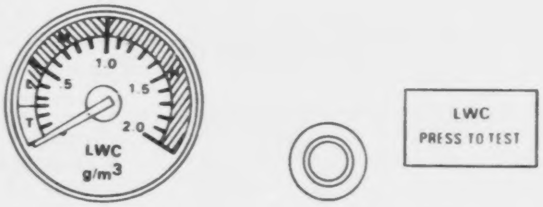


Figure 2-29. Icing Severity Meter and Press-to-Test Switch

2-95. RAIN REMOVAL.

Two wipers are mounted on the canopy frame to wipe the two windshields. Both wipers are electrically driven and are normally controlled by a four-position WSHLD WIPER rotary knob on the pilot ANTI-ICE panel (figure 2-28). The pilot wiper moves horizontally and the CPG wiper moves vertically to maintain a large clear viewing area. They receive power from the 28 vdc emergency bus through the WSHLD WPR circuit breaker on the pilot overhead circuit breaker panel. Two speeds, HIGH and LOW may be selected by the pilot. To return the wipers to their static position adjacent to the canopy frame, the WSHLD WIPER knob is turned to PARK and held momentarily until the blades stop. This knob is spring-loaded from PARK to OFF. The CPG has limited control over the windshield wipers. Normally, the W WIPER switch on the CPG ANTI-ICE panel is left in the PLT position. When the switch is set at CPG, CPG wiper blade moves at low speed. Windshield wipers should not be operated when canopies are dry; scratches may result.

Section X. HEATING, VENTILATING AND DEFOGGING SYSTEM

2-96. ENVIRONMENTAL CONTROL SYSTEM.

Crew compartment ventilating, heating, and air conditioning are provided through an environmental control system (ECS). The ECS is also the primary source of cool air for the two forward avionics compartments. The ECS is comprised of: the envirnomental control unit (ENCU), ECS control panel, manifolds and tubing to deliver pressurized air to the ENCU, and ducting to route conditioned air from the ENCU to the crew stations, forward avionics bay, and TADS/PNVS turret.

a. **Environmental Control System Control Panel.** The ECS control panel is on the pilot left console (figure 2-30). The ECS FAN control switch can be set manually to NORM or STBY FAN. The STBY FAN position is selected if the ENCU fails. This will increase the speed of the forward avionics bay fans to draw additional air from the crew stations for avionics cooling for this ENCU-failed condition. The CPG also has a two-position STBY FAN switch, located on the AUX panel of his left console (figure 2-28). This switch is also normally in the OFF position, but it may be moved to STBY FAN to speed up the forward avionics bay fans in case of ENCU failure. A TEMP rheostat knob on the pilot's panel enables him to control the temperature of conditioned air to the crew station.

b. **Environmental Control Unit.** The ENCU is mounted to the transmission deck on the left side of the airframe and aft of the main transmission. The ENCU (figure 2-30) produces conditioned air with low moisture content. It takes hot pressurized air from the pressurized air system and cools it through a heat exchange and expansion process. Placing the ENCU switch to the ON position energizes the ENCU shutoff valve solenoid and allows pressurized air to enter the ENCU. It directs 28 vdc power to the temperature control sensor for operation of the pilot ECS TEMP control and the temperature control valve on the ENCU. It also applies 28 vdc to the contacts of the thermal overheat switch that controls the ECS lights on the pilot caution/warning panel. The TEMP knob on the pilot ECS control panel controls crew station temperature. Moving the knob to COLD or WARM operates a control valve that determines the amount of hot pressurized air that will be allowed to mix with conditioned air.

c. **Ducting.** Conditioned air leaving the ENCU is routed through kevlar ducting to both crew stations. The crew stations each have four controllable crew air outlets. The CPG station has an additional four nonadjustable outlets to provide ECS air directly to each FAB the TADS and ORT. In the ECS cooling mode the crew station floor outlets (2) are closed and the waist and shoulder outlets are open. For heating mode the crew shoulder outlets are closed and the waist and floor outlets are open. The FAB and TADS fans draw CPG cabin air forward and expel it overboard. Pilot crew station and transmission bay air is drawn through the electrical power center by a ventilation fan and then exhausted into the transmission bay. The aft avionics bay has a vaneaxial fan for ventilation which is controlled by a separate automatic temperature thermostat.

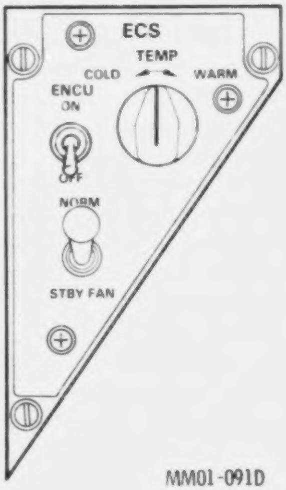


Figure 2-30. ECS Control Panels and System

best copy available

d. **Overtemperature Sensors.** A temperature sensor is located in each FAB downstream of the mixing of conditioned air with CPG crewstation ambient air and prior to ducting into the FAB manifold. The purpose of each temperature sensor is to automatically reduce the warm air temperature demanded by the pilot with the TEMP knob. If, during cold weather operations, the pilot adjusts the TEMP knob to a position such that the temperature of the mixed air would be too hot for the FABs, the temperature sensor will automatically reduce the demanded air temperature. The amount that the temperature sensor can reduce the demanded air temperature is limited. If the temperature of the mixed air exceeds 41°C, the ECS caution light will illuminate. If this occurs, the pilot should reduce the demanded air temperature, but not to a level that adversely affects crew comfort, until the ECS caution light extinguishes. During hot weather operations, if the ECS caution light illuminates the pilot should ensure the TEMP knob is adjusted for full cold. In all cases of ECS light illumination, the mission may be continued.

e. **Ventilating System.** In the event of an ENCU failure, the actions of the pilot depend on the nature of the ambient temperature conditions. Crew station air flow with the ENCU inoperative is through the pilot's station into the CPG station, and out through the forward avionics bays. During cold weather operations, the pilot may at his discretion open the auxiliary ventilation door to periodically ventilate both crew stations. No other action is required. During hot or warm weather operations, the pilot should open the auxiliary ventilation door to provide crew station ventilation. If the ambient temperature is below 38°C, no further action is recommended. If the ambient temperature is above 38°C, the fan switch should be placed in the STBY position. Depending on the ambient outside air temperature, the ECS light may illuminate.

f. **Defogging System.** The CANOPY DEFOG switch (figure 2-28) allows the pilot to direct pressurized air (with ECS ON or OFF) to diffuser outlets at each canopy side panel. When the CANOPY DEFOG switch is placed in the ON position, 28 vdc from the No. 1 dc essential bus energizes the defog valve and causes it to open thus allowing hot air from the pressurized air system to flow through the shutoff valve to the air mixers. The hot pressurized air mixes with the crew station conditioned air in the air mixers. This partially cooled air is directed against the canopy side panels to defog them.

Section XI. ELECTRICAL POWER SUPPLY AND DISTRIBUTION SYSTEM

2-97. ELECTRICAL POWER SYSTEM.

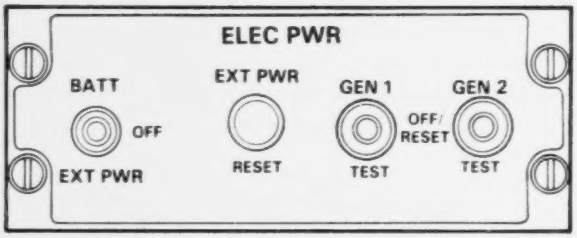
All the helicopter electrical power requirements are supplied by two ac generators, two transformer/rectifiers, and in the case of complete failure, a 24-volt battery will supply flight critical systems. For ground operation, 115 vac external power can be supplied to the helicopter through the external power receptacle. The electrical power distribution system is shown in figure 2-31, and electrical system caution lights are listed in tables 2-5 and 2-6.

2-98. AC POWER SUPPLY SYSTEM.

The ac power supply system is the primary source of electrical power. It supplies 115 vac from two 35 kilovolt-ampere generators. Each generator and its associated components comprise an independent ac generating system that supplies about one-half of the total electrical requirements to the ac buses. The generators are mounted on, and driven by, the main transmission accessory gear box. The 115 vac power is monitored and regulated by the generator control unit (GCU). If the generator output is normal, the GCU applies voltage to the ac contactor which energizes and connects the generator output to the ac essential bus. The ac contactor connects the No. 1 generator output to the ac essential bus 1, and the No. 2 ac contactor connects the No. 2 generator to the ac essential bus 2. If one generator fails, its load is automatically connected to the remaining generator.

2-99. EXTERNAL POWER RECEPTACLE.

The external power receptacle is located aft of the aft avionics bay. It provides a means of connecting external power to the helicopter. A microswitch, which is actuated by opening the external power access door, informs the pilot when the door is open by lighting the EXT PWR lamp on his caution/warning panel. The system is controlled from the ELEC PWR panel on the pilot center console (figure 2-30A). When the BATT/EXT PWR switch is at EXT PWR position, the external power monitor checks the GPU for proper phase sequence, voltage, and frequency thus allowing power to be supplied to the helicopter. The power monitor also inhibits connecting and charging of the battery. Power to operate the EXT PWR caution light is 28 vdc through the CAUT circuit breaker on the pilot overhead circuit breaker panel (figure 2-32).



MM01-203

Figure 2-30A. Electrical Power Panel

2-100. DC POWER SUPPLY SYSTEM.

Two ac essential buses supply power to the two 350-ampere transformer/rectifiers (T/R) via the XFMR RECT circuit breakers. The transformer/rectifiers convert the ac input to 28 vdc. The 28 vdc power is applied to a dc contactor, and the dc contactor routes 28 vdc from T/R 1 to dc essential bus 1 and from T/R 2 to dc essential bus 2. The dc essential buses 1 and 2 each apply 28 vdc, in parallel, through isolation diodes to power the dc emergency bus during normal operation. For emergency operation, the battery powers the dc emergency bus, and the emergency bus diodes isolate the battery from the noncritical loads. The two dc essential buses also supply power to dc essential bus 3. The T/R's are self-monitoring for overtemperature and will illuminate the HOT REC 1, HOT REC 2 lamps when an overheat condition exists. The dc contactor monitors the T/R's for output loss or drop in voltage. If the dc contactor senses a fault in the No. 1 T/R, it disconnects T/R 1 from dc

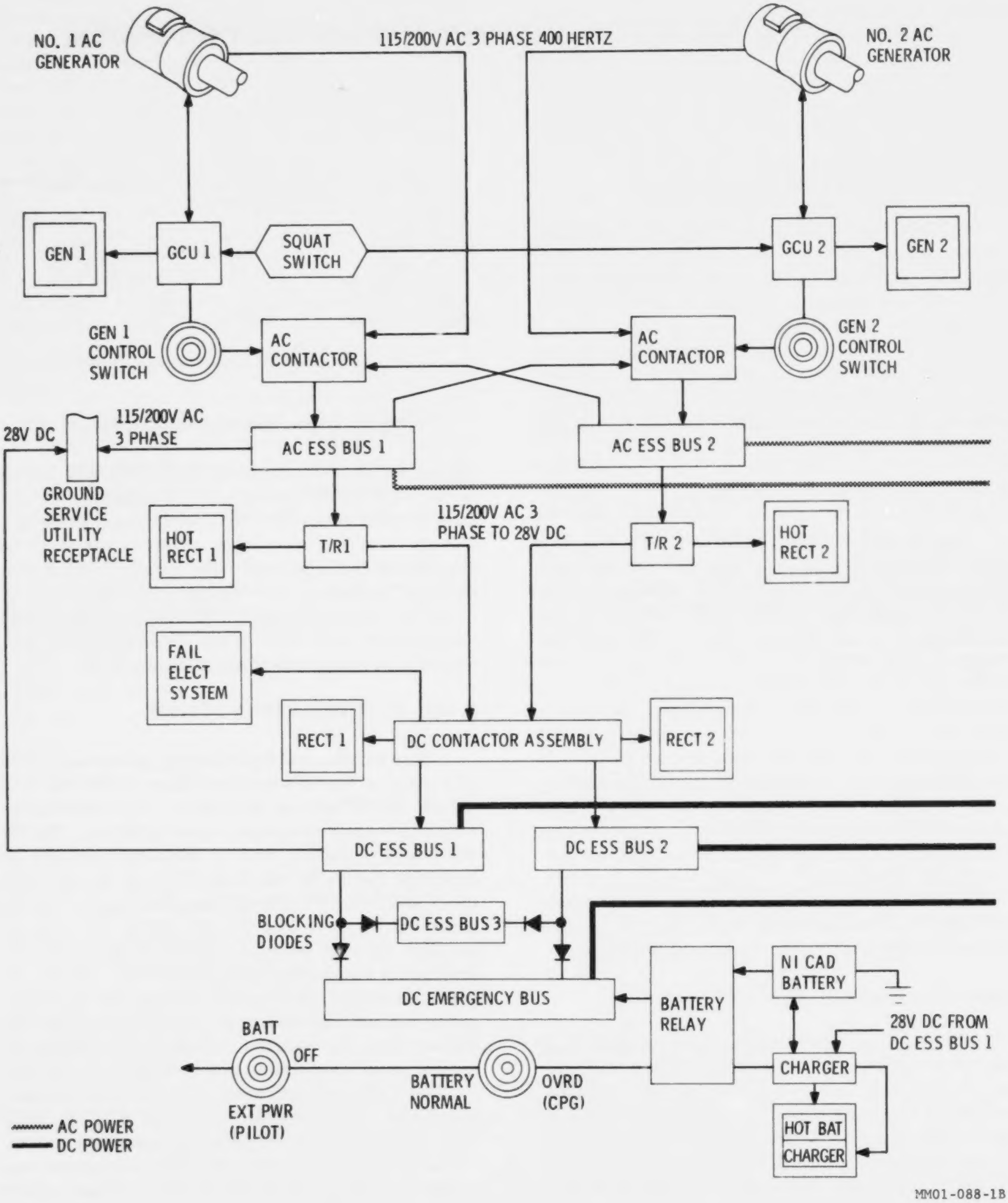
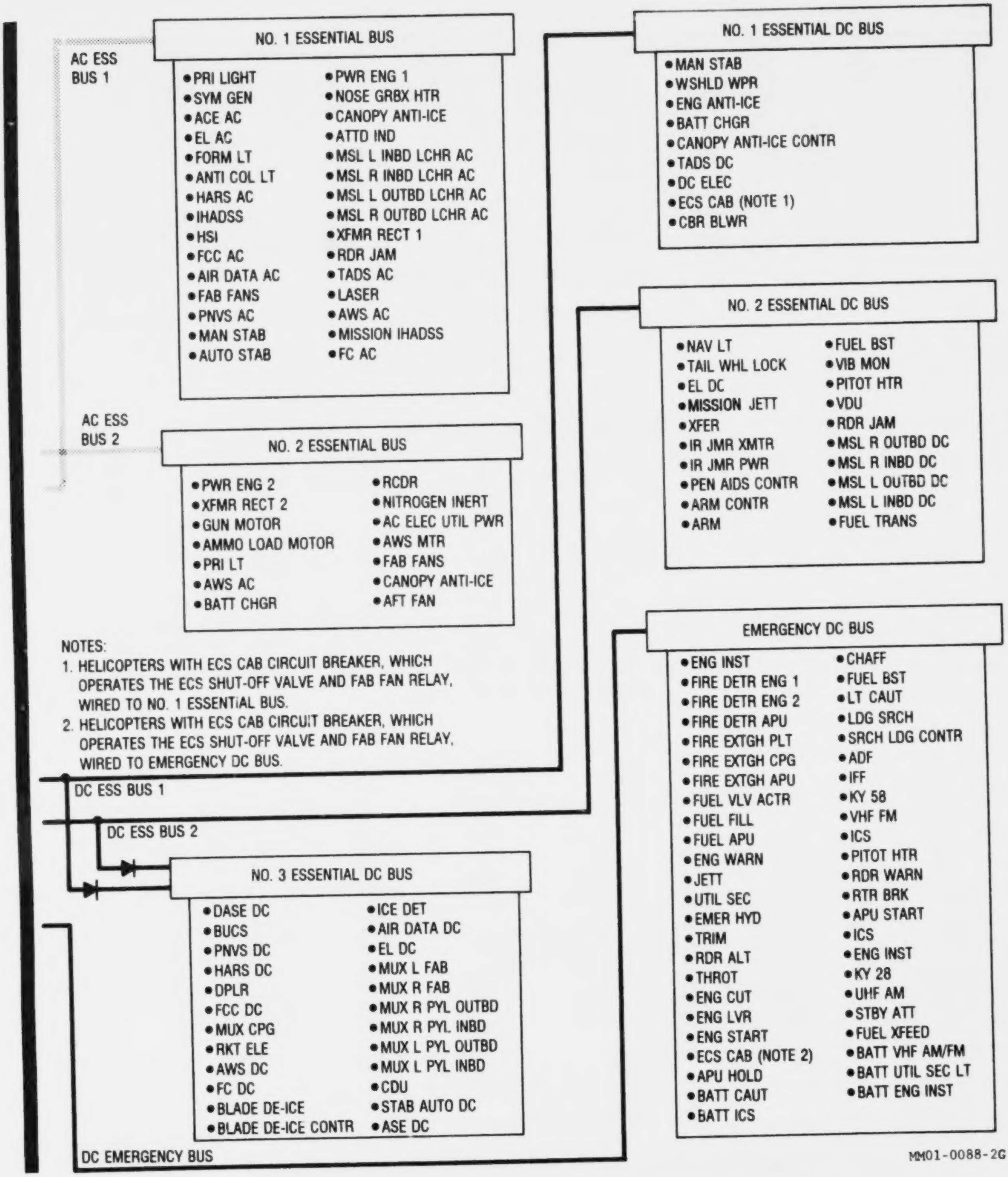

NO. 1 AC GENERATOR
115/200V AC 3 PHASE 400 HERTZ
NO. 2 AC GENERATOR
GEN 1
GCU 1
SQUAT SWITCH
GCU 2
GEN 2
GEN 1 CONTROL SWITCH
AC CONTACTOR
AC CONTACTOR
GEN 2 CONTROL SWITCH
28V DC
115/200V AC 3 PHASE
AC ESS BUS 1
AC ESS BUS 2
GROUND SERVICE UTILITY RECEPTACLE
HOT RECT 1
T/R1
115/200V AC 3 PHASE TO 28V DC
T/R 2
HOT RECT 2
FAIL ELECT SYSTEM
RECT 1
DC CONTACTOR ASSEMBLY
RECT 2
DC ESS BUS 1
DC ESS BUS 2
BLOCKING DIODES
DC ESS BUS 3
NI CAD BATTERY
DC EMERGENCY BUS
BATTERY RELAY
28V DC FROM DC ESS BUS 1
BATT
OFF
CHARGER
BATTERY NORMAL
OVRD (CPG)
EXT PWR (PILOT)
HOT BAT CHARGER
AC POWER
DC POWER
MM01-088-1B

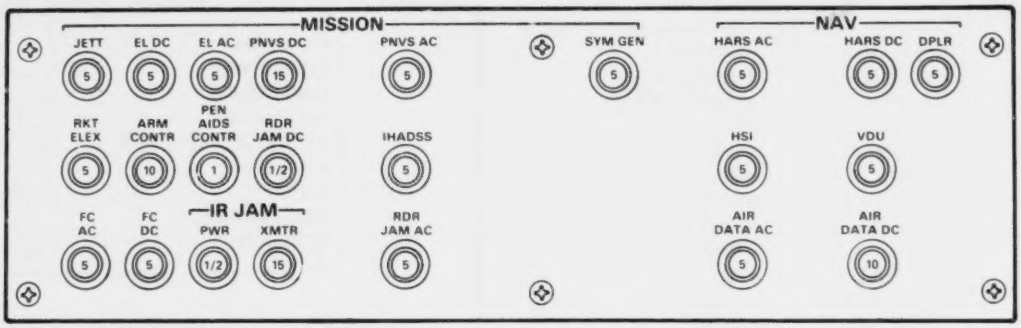
Figure 2-31. Electrical Power Distribution System (Sheet 1 of 2)


NO. 1 ESSENTIAL BUS
AC ESS BUS 1
•PRI LIGHT
•SYM GEN
•ACE AC
•EL AC
•FORM LT
•ANTI COL LT
•HARS AC
•IHADSS
•HSI
•FCC AC
•AIR DATA AC
•FAB FANS
•PNVS AC
•MAN STAB
•AUTO STAB
•PWR ENG 1
•NOSE GRBX HTR
•CANOPY ANTI-ICE
•ATTD IND
•MSL L INBD LCHR AC
•MSL R INBD LCHR AC
•MSL L OUTBD LCHR AC
•MSL R OUTBD LCHR AC
•XFMR RECT 1
•RDR JAM
•TADS AC
•LASER
•AWS AC
•MISSION IHADSS
•FC AC
AC ESS BUS 2
NO. 2 ESSENTIAL BUS
•PWR ENG 2
•XFMR RECT 2
•GUN MOTOR
•AMMO LOAD MOTOR
•PRI LT
•AWS AC
•BATT CHGR
•RCDR
•NITROGEN INERT
•AC ELEC UTIL PWR
•AWS MTR
•FAB FANS
•CANOPY ANTI-ICE
•AFT FAN
NO. 1 ESSENTIAL DC BUS
•MAN STAB
•WSHLD WPR
•ENG ANTI-ICE
•BATT CHGR
•CANOPY ANTI-ICE CONTR
•TADS DC
•DC ELEC
•ECS CAB (NOTE 1)
•CBR BLWR
NO. 2 ESSENTIAL DC BUS
•NAV LT
•TAIL WHL LOCK
•EL DC
•MISSION JETT
•XFER
•IR JMR XMTR
•IR JMR PWR
•PEN AIDS CONTR
•ARM CONTR
•ARM
•FUEL BST
•VIB MON
•PITOT HTR
•VDU
•RDR JAM
•MSL R OUTBD DC
•MSL R INBD DC
•MSL L OUTBD DC
•MSL L INBD DC
•FUEL TRANS
EMERGENCY DC BUS
•ENG INST
•FIRE DETR ENG 1
•FIRE DETR ENG 2
•FIRE DETR APU
•FIRE EXTGH PLT
•FIRE EXTGH CPG
•FIRE EXTGH APU
•FUEL VLV ACTR
•FUEL FILL
•FUEL APU
•ENG WARN
•JETT
•UTIL SEC
•EMER HYD
•TRIM
•RDR ALT
•THROT
•ENG CUT
•ENG LVR
•ENG START
•ECS CAB (NOTE 2)
•APU HOLD
•BATT CAUT
•BATT ICS
•CHAFF
•FUEL BST
•LT CAUT
•LDG SRCH
•SRCH LDG CONTR
•ADF
•IFF
•KY 58
•VHF FM
•ICS
•PITOT HTR
•RDR WARN
•RTR BRK
•APU START
•ICS
•ENG INST
•KY 28
•UHF AM
•STBY ATT
•FUEL XFEED
•BATT VHF AM/FM
•BATT UTIL SEC LT
•BATT ENG INST
DC ESS BUS 1
DC ESS BUS 2
NO. 3 ESSENTIAL DC BUS
•DASE DC
•BUCS
•PNVS DC
•HARS DC
•DPLR
•FCC DC
•MUX CPG
•RKT ELE
•AWS DC
•FC DC
•BLADE DE-ICE
•BLADE DE-ICE CONTR
•ICE DET
•AIR DATA DC
•EL DC
•MUX L FAB
•MUX R FAB
•MUX R PYL OUTBD
•MUX R PYL INBD
•MUX L PYL OUTBD
•MUX L PYL INBD
•CDU
•STAB AUTO DC
•ASE DC
DC EMERGENCY BUS

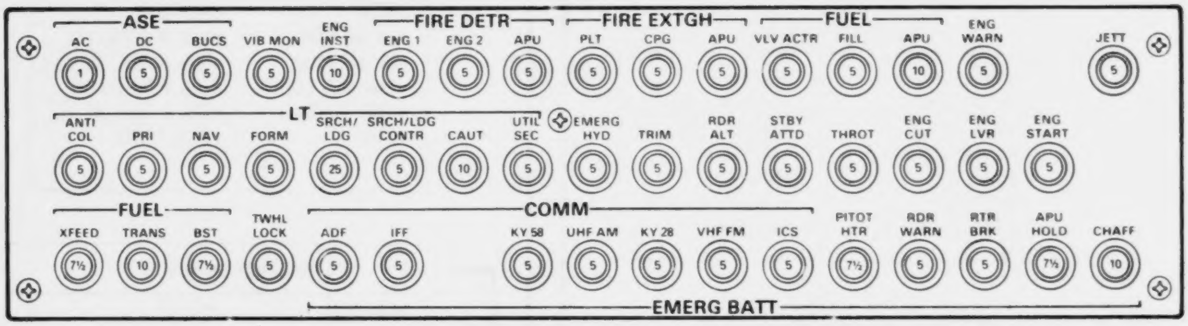
NOTES:
1. HELICOPTERS WITH ECS CAB CIRCUIT BREAKER, WHICH OPERATES THE ECS SHUT-OFF VALVE AND FAB FAN RELAY, WIRED TO NO. 1 ESSENTIAL BUS.
2. HELICOPTERS WITH ECS CAB CIRCUIT BREAKER, WHICH OPERATES THE ECS SHUT-OFF VALVE AND FAB FAN RELAY, WIRED TO EMERGENCY DC BUS.

MM01-0088-2G

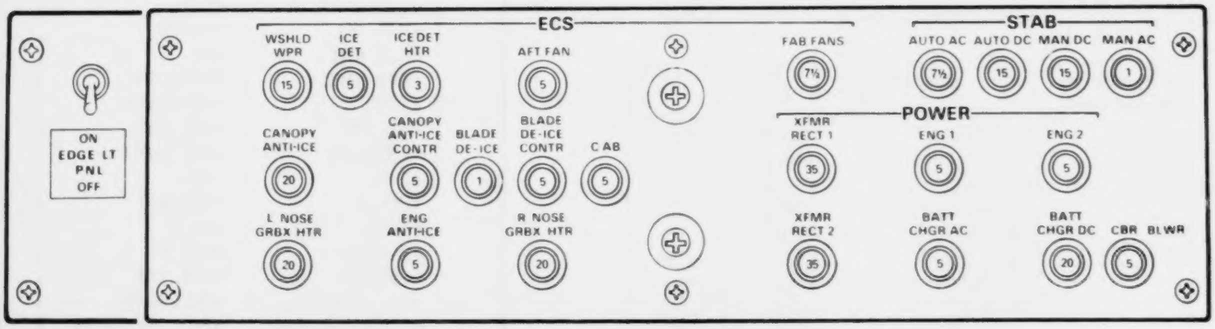
Figure 2-31. Electrical Power Distribution System (Sheet 2 of 2)


MISSION
JETT
5
EL DC
5
EL AC
5
PNVS DC
15
PNVS AC
5
SYM GEN
5
NAV
HARS AC
5
HARS DC
5
DPLR
5
RKT ELEX
5
ARM CONTR
10
PEN AIDS CONTR
1
RDR JAM DC
1/2
IHADSS
5
HSI
5
VDU
5
IR JAM
FC AC
5
FC DC
5
PWR
1/2
XMTR
15
RDR JAM AC
5
AIR DATA AC
5
AIR DATA DC
10

FORWARD CIRCUIT BREAKER PANEL


ASE
AC
1
DC
5
BUCS
5
VIB MON
5
ENG INST
10
FIRE DETR
ENG 1
5
ENG 2
5
APU
5
FIRE EXTGH
PLT
5
CPG
5
APU
5
FUEL
VLV ACTR
5
FILL
5
APU
10
ENG WARN
5
JETT
5
LT
ANTI COL
5
PRI
5
NAV
5
FORM
5
SRCH/ LDG
25
SRCH/LDG CONTR
5
CAUT
10
UTIL SEC
5
EMERG HYD
5
TRIM
5
RDR ALT
5
STBY ATTD
5
THROT
5
ENG CUT
5
ENG LVR
5
ENG START
5
FUEL
XFEED
7½
TRANS
10
BST
7½
TWHL LOCK
5
COMM
ADF
5
IFF
5
KY 58
5
UHF AM
5
KY 28
5
VHF FM
5
ICS
5
PITOT HTR
7½
RDR WARN
5
RTR BRK
5
APU HOLD
7½
CHAFF
10
EMERG BATT

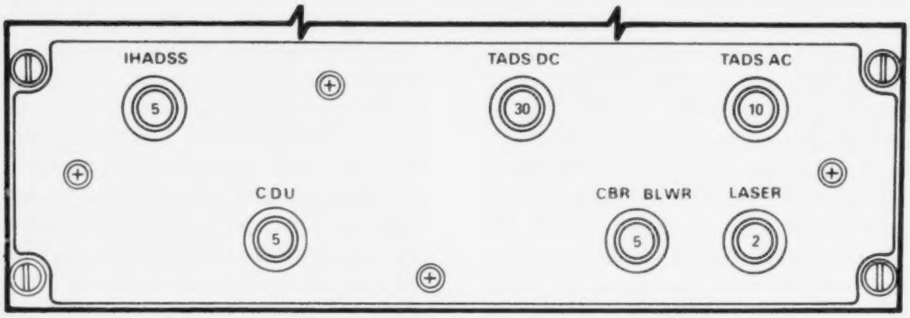
CENTER CIRCUIT BREAKER PANEL


ON
EDGE LT
PNL
OFF
ECS
WSHLD WPR
15
ICE DET
5
ICE DET HTR
3
AFT FAN
5
FAB FANS
7½
STAB
AUTO AC
7½
AUTO DC
15
MAN DC
15
MAN AC
1
CANOPY ANTI-ICE
20
CANOPY ANTI-ICE CONTR
5
BLADE DE-ICE
1
BLADE DE-ICE CONTR
5
C AB
5
POWER
XFMR RECT 1
35
ENG 1
5
ENG 2
5
L NOSE GRBX HTR
20
ENG ANTI-ICE
5
R NOSE GRBX HTR
20
XFMR RECT 2
35
BATT CHGR AC
5
BATT CHGR DC
20
CBR BLWR
5

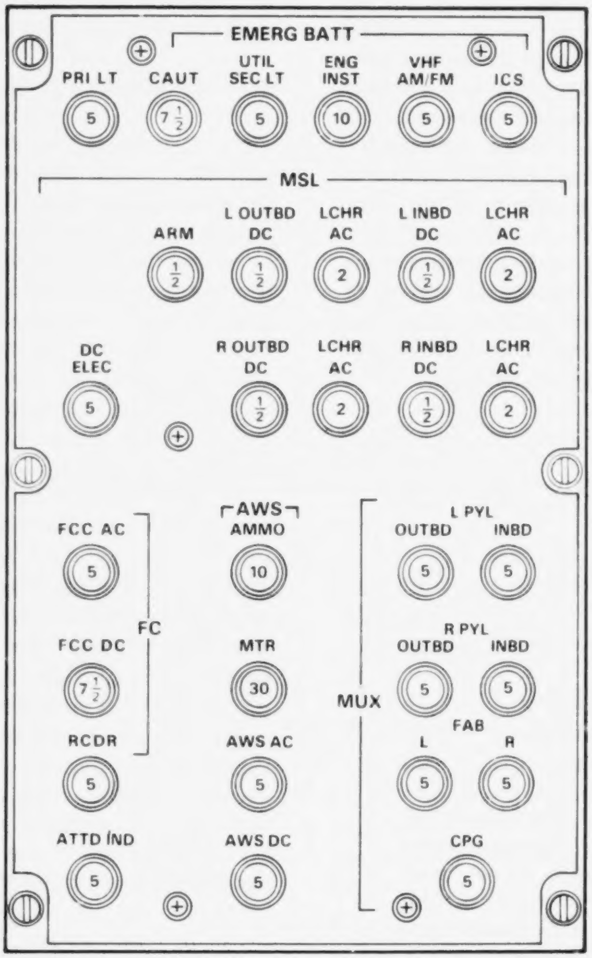
AFT CIRCUIT BREAKER PANEL

MM01-038D

Figure 2-32 Pilot's Canopy Rail Circuit Breaker Panels (Typical)


IHADSS
5
TADS DC
30
TADS AC
10
CDU
5
CBR BLWR
5
LASER
2

CPG NO. 2 CIRCUIT BREAKER PANEL


EMERG BATT
PRI LT
5
CAUT
7 1/2
UTIL SEC LT
5
ENG INST
10
VHF AM/FM
5
ICS
5
MSL
ARM
1/2
L OUTBD DC
1/2
LCHR AC
2
L INBD DC
1/2
LCHR AC
2
DC ELEC
5
R OUTBD DC
1/2
LCHR AC
2
R INBD DC
1/2
LCHR AC
2
FCC AC
5
FC
FCC DC
7 1/2
RCDR
5
ATTD IND
5
AWS
AMMO
10
MTR
30
AWS AC
5
AWS DC
5
MUX
L PYL
OUTBD
5
INBD
5
R PYL
OUTBD
5
INBD
5
FAB
L
5
R
5
CPG
5

CPG NO. 1 CIRCUIT BREAKER PANEL

M101-019C

Figure 2-33 Copilot/Gunner's Circuit Breaker Panels (Typical)

essential bus 1 and routes a fault signal to turn on the RECT 1 lamp on the pilot caution/warning panel. At the same time, it connects dc essential bus 1 to dc essential bus 2 through relay action inside the contactor. The same action takes place if the No. 2 T/R fails. If both T/R's fail, the ELEC SYS FAIL lamp on the CPG caution/warning panel will illuminate. Power to operate the caution lights is from 28 vdc through the CAUT circuit breaker on the pilot overhead circuit breaker panel and 28 vdc through the EMERG BATT CAUT circuit breaker on the CPG main circuit breaker panel.

2-101. GENERATORS

Two generators located on the main transmission accessory gearbox supply 115 vac, three-phase power for operating the helicopter electrical equipment. Generator operation is controlled from the ELEC PWR panel on the pilot left console (figure 2-11). When a generator control switch is in GEN 1 or GEN 2 position, the selected generator(s) are brought on-line. When the switch is placed to OFF/RESET, the generator is taken off-line and resets fault sensing. Two generator caution lights, GEN 1 and GEN 2 on the pilot caution/warning panel (figure 2-38), come on whenever the generator control unit senses a fault. Power to operate these lights is 28 vdc through the CAUT circuit breaker on the pilot overhead circuit breaker panel.

2-102. BATTERY.

A 24-volt, 13-ampere-hour, 19 cell, nickel-cadmium battery provides emergency power. The battery is located in the aft avionics bay. The battery is charged by routing 28 vdc power to the battery charger from the dc essential bus 1 via the BATT CHGR DC circuit breaker, and 115 vac from the BATT CHGR AC circuit breaker from ac bus 2. The battery charger will completely charge the battery and then maintain a trickle charge. The battery charger also contains fault sensing that monitors battery temperature, cell balance, and charger operation. If a fault occurs, a fault signal is sent to turn on the HOT BAT/CHARGER caution light on the pilot caution/warning panel. The helicopter is equipped with a battery heater which operates automatically when the battery is on.

2-103. CPG Battery Override Switch.

A two-position guarded toggle BAT OVRD switch is located on the CPG power lever quadrant. With the guard down, the switch is in the NRML position and enables the pilot EXT PWR/BATT switch on the pilot ELEC PWR control panel. When the guard is positioned up and the switch is set to OVRD, the pilot EXT PWR/BATT switch is disabled, and the battery is disconnected from the emergency bus.

Section XII. AUXILIARY POWER UNIT (APU)

2-104 AUXILIARY POWER UNIT (APU).

WARNING

To prevent accidental APU start, the APU circuit breaker in the AFT avionics bay and the APU HOLD circuit breaker on the pilot's center circuit breaker panel shall be out when battery or external electrical power is connected to the helicopter and unqualified personnel are in/around the pilot's crew compartment.

The auxiliary power unit indirectly provides hydraulic, pneumatic, and electrical power for the operation of helicopter systems whenever the engines are not driving the main transmission accessory section. The APU provides the means of engine starting without the need for a ground power unit (GPU). It is located just inboard of the right engine nacelle in the aft equipment bay. The APU consists of the gearbox, compressor, and the turbine section, together with associated fuel, lubrication, and electrical systems. The APU controller and the APU control panel are integral with, but installed separately from, the APU.

a. Fuel System. The aft fuel cell provides all fuel for APU operation and is discussed in more detail in Section IV of this chapter. The APU fuel control automatically regulates fuel flow, the APU burns approximately 135 PPH fuel flow rate.

b. **Lubrication System.** The APU has a self-contained oil system. An oil filler cap is located on the left side of the unit. Oil cooling is provided by airflow over cooling fins at the compressor inlet. The oil level sight gage is located on the right side and is an integral part of the oil sump. The sight gage can be inspected through an opening just below the right engine nacelle.

c. **Electrical System.** The APU electrical system requires dc power which is normally delivered by the helicopter battery when the APU control switch is set to RUN. This switch will apply dc power to energize the APU boost pump, open the APU fuel shutoff valve, and at the same time, send a signal to open the utility accumulator start solenoid valve to allow hydraulic pressure to turn the starter, and shut off the SDC inlet throttle valve to unload the SDC for an APU start.

d. **APU Controller.** The APU controller provides for automatic start and operation of the APU and power take-off clutch (PTO) engagement. The controller monitors the APU for loss of thermocouple, overtemp, overspeed, overcurrent, low oil pressure, percent rpm, and exhaust gas temperature. The APU controller transmits a shutdown signal to the APU whenever the control panel switch is set to OFF; the controller transmits the shutdown signal automatically for fault detection of any of the monitored functions. An APU FAIL caution light on the pilot caution/warning panel is energized by the low oil pressure switch when automatic shutdown occurs. An APU ON light illuminates when the APU is functioning. The PTO clutch actuation is also controlled by the APU controller. Normally, PTO clutch engagement occurs at 60% APU speed if the main rotor is below 90% speed; however, if the main rotor is above 90% speed, it will engage at 95% APU speed. For cold weather starts below −0°F (−18°C), PTO clutch engagement is at 95% APU speed by way of a cold start switch on the APU panel.

e. **Utility Hydraulic Accumulator.** The utility hydraulic accumulator is discussed in more detail in Section VI of this chapter. It should be noted, however, that the accumulator, located on the deck of the aft equipment bay below the APU, provides hydraulic pressure to the APU hydraulic starter through a solenoid-operated hydraulic start valve. The start valve opens when the APU start switch is positioned to START and closes automatically at 60% APU speed.

f. **APU Control Panel.** The APU control panel (figure 2-14), on the pilot right console, has five distinct functions.

(1) A three-position APU control switch allows the pilot to start, run, and shut down the APU. This switch is spring-loaded from the START to RUN position. Pilot pressure at the START position is required for only one or two seconds to ensure electrical circuit latching.

(2) During cold weather start at temperatures below −0°F (−18°C), place the 95% switch at 95 percent. This prevents engagement of the PTO clutch until the APU has reached 95% N_G (operating speed).

(3) APU fire warning is provided by a warning light in the APU FIRE PULL handle and a FIRE APU warning light on the pilot and CPG master caution/warning panel. Section II of this chapter describes emergency equipment operation.

(4) An APU fire can be extinguished by pulling the pilot APU FIRE PULL handle and placing the FIRE BTL selector switch either to PRI (primary) or RES (reserve).

(5) The fire test portion of the panel is discussed in detail in Section II of this chapter.

Figure 2-34. Auxiliary Power Unit (APU) Deleted

Section XIII. LIGHTING

2-105. LIGHTING EQUIPMENT.

The lighting equipment consists of exterior and interior lighting systems.

NOTE

The searchlight, crew station flood lights, and utility lights are the only lights available under battery power.

2-106. Exterior Lighting System.

The aircraft exterior lighting system consists of formation lights, navigation lights, anticollision lights, a searchlight, and an inspection maintenance light.

a. **Formation Lights**. The formation lights (green) are located on the upper surface of each wing, the upper centerline of the aft fuselage, and on the upper surface of the vertical stabilizer. Power for operation of the lights is 115 vac provided by the FORM circuit breaker on the pilot overhead circuit breaker panel. Operation of the lights is controlled by the FORM rotary control on the pilot EXT LTS panel (figure 2-35).

b. **Navigation Lights**. The navigation lights are located on the wingtips (right side green, left side red); the aft light (white) is located on the top aft side of the vertical stabilizer. Power for operation of the lights is 28 vdc and is provided by the NAV circuit breaker on the pilot overhead circuit breaker panel. Operation of the lights is controlled by the NAV switch on the pilot EXT LTS panel (figure 2-35).

c. **Anticollision Lights**. High-intensity flashing red and white anticollision lights are located on each wingtip. Power for their operation is 115 vac through the ANTI COL circuit breaker and 28 vdc through the LT NAV circuit breaker on the pilot overhead circuit breaker panel. Operation of the lights is controlled by the ANTI-COL switch on the pilot EXT LTS panel (figure 2-35).

d. **Searchlight**. The searchlight (figure 2-1) is located in a fairing under the forward end of the forward avionics bay just forward of the landing gear attachment and can be used as a landing light. Searchlight motion is inhibited for 60 seconds after the switch is placed in stow position. Power for the searchlight is 28 vdc routed through a relay by the SRCH/LDG CONTR and SRCH/LDG circuit breakers on the pilot overhead circuit breaker panel. Operation of the light is controlled by the SRCH LT and round-EXT-RET switches on the pilot and CPG collective stick switchboxes (figure 2-22).

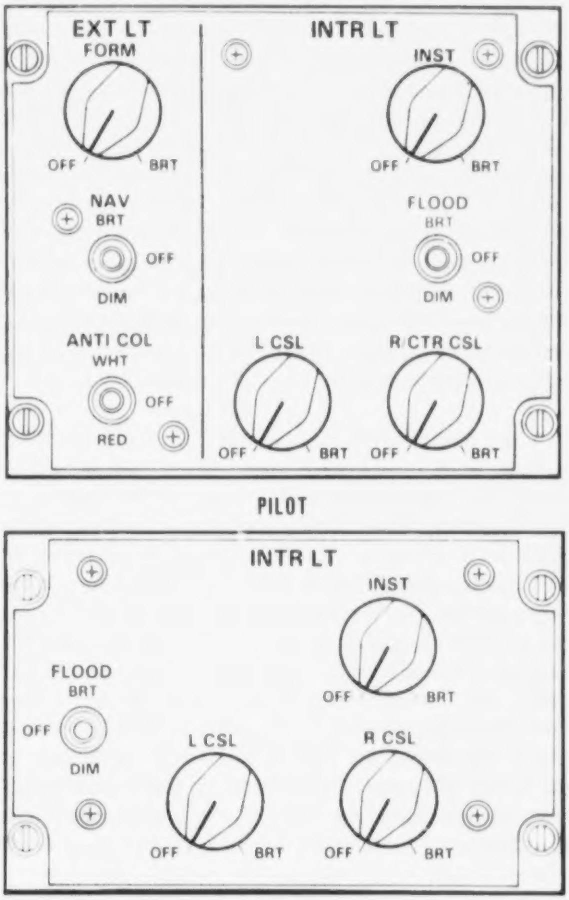


Figure 2-35. Pilot and Copilot/Gunner Lighting Control Panels

e. **Inspection and Maintenance Light**. The inspection and maintenance light is stored in the left equipment stowage compartment (figure 2-1). Two plug-in receptacle locations provide electrical power and will facilitate inspection and maintenance at all points on the helicopter. The receptacle is located adjacent to the CPG station on the underside of the right FAB, forward of the searchlight (figure 2-1). The second receptacle is located in the right aft avionics bay (figure 2-1). Power for operating the light is 24 vdc directly from the battery through the MAINT LT circuit breaker in the right aft avionics bay. Operation of the inspection and maintenance light is controlled by an OFF-BRT rheostat switch which is integral with the light.

2-107. Interior Lighting System.

The helicopter interior lighting system consists of dimming lighting for engine instruments, flight instruments, avionics panels, console panels, and circuit breaker panels. All engine and flight instruments are equipped with red surface-mounted edge lighting fixtures, and the avionics console and circuit breaker panel lights are integrally illuminated. Light is reflected to illuminate the panel markings and the clear edging around each switch or circuit breaker. In the event of total electrical power generation failure, the pilot and CPG flood lights, utility lights, and searchlight remain operable through the dc emergency bus.

a. **Pilot Interior Lighting**. Interior lighting for the pilot is operated and controlled by three INTR LT switch/rheostats and a three-position FLOOD toggle switch located on the left console. The three INTR LT switch/rheostats provide an OFF position and dim to BRT position. AC voltage is the primary power for the interior lights. The ac voltage is applied to a multichannel dimmer assembly through the PRI circuit breaker on the pilot overhead circuit breaker panel. The multichannel dimmer converts 115 vac to the proper dc levels for the three switch/rheostats on the INTR LT panel. The INST, L CSL, and R/CTR CSL switch/rheostats vary the multichannel dimmer output. The INST control controls channels 1 and 2 of the multichannel dimmer. Channel 1 is for the right instrument panel, and channel 2 is for the left instrument panel. Both channels vary the multichannel output from zero (OFF position) to 5 vdc (BRT). The R/CTR CSL control is split into two sections. A: zero, OFF position, and 5 vdc BRT for APU FIRE TEST and APX100 control panel. B: zero, OFF position, and 28 vdc BRT for the avionics control box lights in the center and right console. The L CSL controls the circuit breaker panels and the collective stick grip lights. The pilot also has an EDGE LT PNL ON/OFF switch located on the overhead circuit breaker panel that allows him to turn off circuit breaker edge lights independent of other console lights.

b. **CPG Interior Lighting**. The CPG interior lighting operation of the INTR LTS switch/rheostats and the multichannel dimmer are the same as for the pilot's operation. The INST switch/rheostat controls outputs to channel 1 (right side instruments), channel 2 (left side instruments), and the ORT. The R CSL controls outputs to channel 3 which is split into sections A and B. A: zero to 28 vdc to the avionics lights; B: zero to 5 vdc to the ASN 128 panel lights. The L CSL controls the circuit breaker and collective stick grip lights.

c. **Emergency Floodlight System**. The emergency floodlight system is installed under the glareshields of the pilot and CPG instrument panels. Power for the emergency floodlight system is emergency bus 28 vdc power through the UTIL SEC circuit breaker on the pilot overhead circuit breaker panel (figure 2-32) and the UTIL SEC LT circuit breaker on the CPG main circuit breaker panel (figure 2-33). Operation of the emergency floodlight system is controlled by the FLOOD three-position toggle switch on the pilot and CPG INTR LT control panels (figure 2-35). When the switch is positioned to the BRT position, it turns on the blue green secondary lights to the brightest level. When in the dim position, the secondary lighting is dimmed.

d. **Utility Light**. A detachable utility light with a coiled extension cord is located to the left of the pilot and CPG seats. The utility light provides emergency red or white lighting in case instrument panel lighting fails. The light is operated by an OFF BRT rheostat switch integral with the light. Rotating the front section of the light selects white flood or red flood. Power for the utility light is emergency 28 vdc through the UTIL SEC LT circuit breaker on the pilot overhead circuit breaker panel (figure 2-32), and the UTIL SEC LT circuit breaker on the CPG main circuit breaker panel (figure 2-33).

e. **Dimming, Master Caution Warning Panel, and Caution/Warning Advisory Panels Segment Lights**. Dimming of all caution/warning lights is controlled by the INST control on both the pilot and CPG INTR LT control panels for the respective crew station. When the INST control is in the OFF position, caution/warning lights are bright; any other position will cause the respective lights to go to a preset dim condition.

Section XIV. FLIGHT INSTRUMENTS

2-108. FLIGHT INSTRUMENTS.

The instruments discussed in this section are, for the most part, those that directly measure flight performance. Caution, warning, and audio systems also are explained. Not all flight instruments are common to both crew stations, and for simplicity, may be grouped as follows:

a. **Common Flight Instruments**. The flight instruments found in both crew stations are the pressure (barometric) altimeter, instantaneous vertical speed indicator, airspeed indicator, attitude indicator, and clock.

b. **Pilot Flight Instruments**. The flight instruments found only on the pilot instrument panel are the video display unit, magnetic compass, free air temperature gage, accelerometer, and radar altimeter.

c. **CPG Flight Instruments**. The only flight instrument peculiar to the front crew station is the radio magnetic indicator.

2-109. Pitot-Static System.

Electrically-heated pitot tubes are installed at the outboard leading edge of both wings. Two associated static ports are installed flush with the fuselage: one on the right, and one on the left. The right wing pitot tube supplies ram air to the pilot airspeed indicator, and the left wing pitot tube supplies ram air to the CPG airspeed indicator. The static port on the right side of the fuselage provides static air pressure to the pilot barometric altimeter, rapid response vertical speed indicator, air speed indicator, No. 2 airspeed transducer, and the air data processor. The static port on the left side of the fuselage provides static air pressure to the CPG barometric altimeter, rapid response vertical speed indicator, airspeed indicator, and No. 1 airspeed transducer.

2-110. Barometric Altimeters (AAU-31/A).

Each crew station instrument panel (figure 2-9 and figure 2-10) has a barometric altimeter that reacts to changes in barometric pressure delivered via the static ports. Instrument range is from -1000 to +50,000 feet, although the instruments are not calibrated above 20,000 feet. The altimeter is graduated in 50-foot increments and marked at 100-foot intervals (0-9 x 100). Just left of center is a 100-foot drum and a 1000-foot drum to supplement the scale pointer. The scale window, at the lower right section of the instrument face, indicates barometric pressure setting in inches of mercury. It is adjustable by use of the barometric pressure set knob on the lower left corner of the indicator case. Maximum allowable altimeter error is 70 feet.

2-111. Clocks.

The clocks installed in the instrument panel (figure 2-9 and figure 2-10) of each crew station combine the features of a standard clock and a stopwatch by displaying normal and elapsed time in hours, minutes, and seconds. Once wound, the clocks will run for eight days. The elapsed-time pushbutton control is on the upper right corner of the case. The clock is wound and set with the knob at the lower left corner of the case.

2-112. VIDEO DISPLAY UNIT (VDU).

The video display unit is a multipurpose instrument that provides the pilot with flight, navigation, and targeting information. Regarding the latter functions, the VDU will be discussed again in Chapter 4. A turn-and-slip indicator is located below the face of the cathode ray tube. The drive signals for the turn indicator are provided to the VDU from the DASE.

2-113. Deleted.

2-114. Standby Magnetic Compass.

The standby magnetic compass is attached to the pilot glareshield (figure 2-9) just left of center. Primary heading information is taken from the horizontal situation indicator, which is discussed in Chapter 3, Section III.

2-115. Free (Outside) Air Temperature Indicator.

The free air temperature indicator is a self-contained unit mounted to the bulkhead adjacent to, and left of, the pilot power quadrant (figure 2-11). A probe extends through the airframe to sense outside free air temperature. The dial, marked OAT, indicates in degrees Celsius.

2-116. Accelerometer.

The accelerometer, located on the pilot instrument panel (figure 2-9) measures the g-forces during flight.

2-117. Radio Magnetic Indicator (RMI).

The RMI, at the bottom center of the CPG right instrument cluster (figure 2-10), displays magnetic heading and ADF bearing to a selected station. This latter function will be discussed in Chapter 3 in conjunction with direction finder set AN/ARN-89. Magnetic heading is provided through a synchro signal from the heading/attitude reference set (HARS) to a heading servo that positions the heading compass card within the instrument. When the HARS is alining or failed, a heading warning signal will cause the OFF flag (right center on the instrument face) to appear. Internal power to the RMI is provided by 115 vac 400 Hz input power.

2-118. Pilot and CPG Master Caution and Warning Panels.

The master caution and warning panels, located at the center of the pilot and right center of the CPG glareshield (figures 2-9 and 2-10), are identical. When the PRESS TO TEST pushbutton (figure 2-37) is pressed, all caution/warning lights in that crew station illuminate. All segments have two lamps so that failure of a single lamp will produce only a dimming effect. If a segment fails to light, it indicates either the failure of both lamps or a defective circuit. The MASTER CAUTION display is also pushbutton operated; it is the only amber light on the master caution and warning panel. Initially, when a caution/warning panel segment illuminates, it will flash. Simultaneously, the MASTER CAUTION will flash. Pressing the MASTER CAUTION will extinguish it and convert the illuminated fault segment to steady on. The MASTER CAUTION lights are individually reset in each crew station. It will remain on until the fault or condition is corrected. Warning lights are red, and when lit, require immediate crewmember attention. The master caution and warning panel segments are shown in figure 2-37 and explained in table 2-4.

2-119. Pilot and CPG Caution/Warning Panels.

Although different in size and content, the caution/warning panels, shown in figure 2-38 and explained in tables 2-5 and 2-6, are functionally similar. Primarily cautionary in nature, the panels also include red warning segments. Often a specific fault indicated on the pilot panel will only light a general system segment on the CPG panel. Illumination of a segment on one crew members panel will not cause illumination of the MASTER CAUTION light in the other crew station.

2-120. Warning and Caution Segment Dimming.

All caution and warning segments may be dimmed. When the INST control knob in one of the INTR LT panels (figure 2-35) is OFF, all segments in that crew station are at maximum brightness. As the knob is turned clockwise from the OFF position to BRT, all segments are dim.

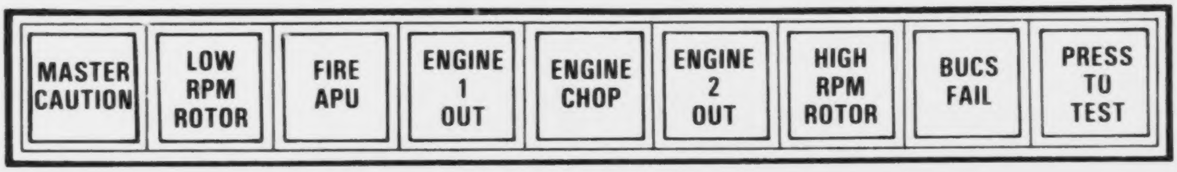
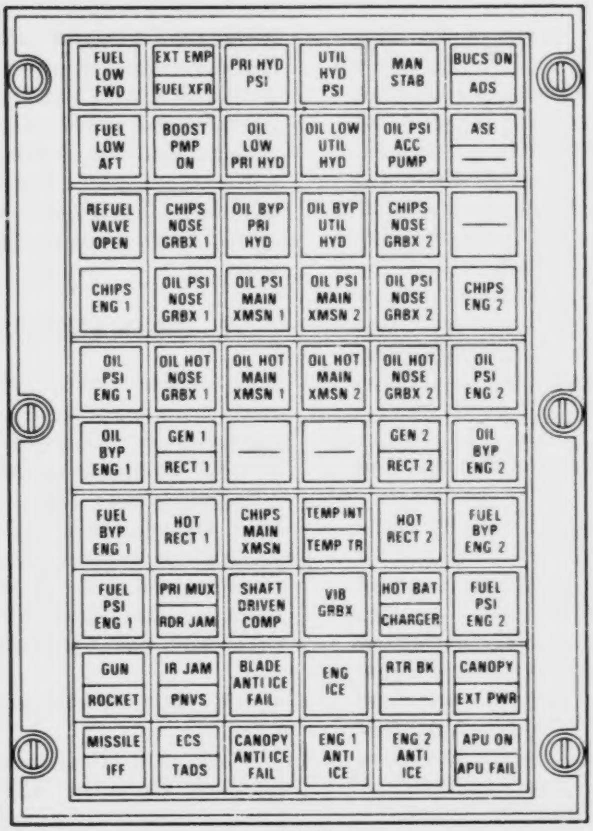
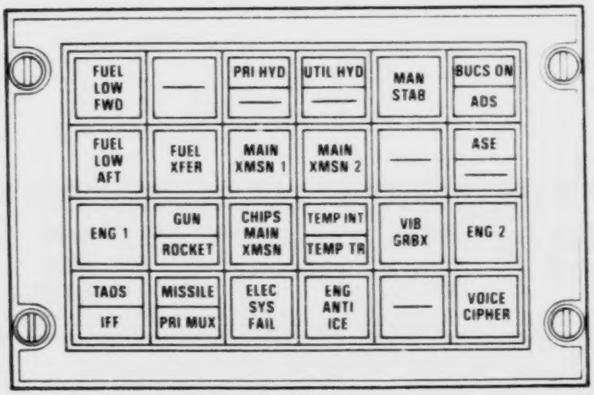


Figure 2-37. Pilot and CPG Master Caution and Warning Panel


FUEL LOW FWD
EXT EMP
FUEL XFR
PRI HYD PSI
UTIL HYD PSI
MAN STAB
BUCS ON
ADS
FUEL LOW AFT
BOOST PMP ON
OIL LOW PRI HYD
OIL LOW UTIL HYD
OIL PSI ACC PUMP
ASE
REFUEL VALVE OPEN
CHIPS NOSE GRBX 1
OIL BYP PRI HYD
OIL BYP UTIL HYD
CHIPS NOSE GRBX 2
CHIPS ENG 1
OIL PSI NOSE GRBX 1
OIL PSI MAIN XMSN 1
OIL PSI MAIN XMSN 2
OIL PSI NOSE GRBX 2
CHIPS ENG 2
OIL PSI ENG 1
OIL HOT NOSE GRBX 1
OIL HOT MAIN XMSN 1
OIL HOT MAIN XMSN 2
OIL HOT NOSE GRBX 2
OIL PSI ENG 2
OIL BYP ENG 1
GEN 1
RECT 1
GEN 2
RECT 2
OIL BYP ENG 2
FUEL BYP ENG 1
HOT RECT 1
CHIPS MAIN XMSN
TEMP INT
TEMP TR
HOT RECT 2
FUEL BYP ENG 2
FUEL PSI ENG 1
PRI MUX
RDR JAM
SHAFT DRIVEN COMP
VIB GRBX
HOT BAT
CHARGER
FUEL PSI ENG 2
GUN
ROCKET
IR JAM
PNVS
BLADE ANTI ICE FAIL
ENG ICE
RTR BK
CANOPY
EXT PWR
MISSILE
IFF
ECS
TADS
CANOPY ANTI ICE FAIL
ENG 1 ANTI ICE
ENG 2 ANTI ICE
APU ON
APU FAIL

PILOT


FUEL LOW FWD
PRI HYD
UTIL HYD
MAN STAB
BUCS ON
ADS
FUEL LOW AFT
FUEL XFER
MAIN XMSN 1
MAIN XMSN 2
ASE
ENG 1
GUN
ROCKET
CHIPS MAIN XMSN
TEMP INT
TEMP TR
VIB GRBX
ENG 2
TADS
IFF
MISSILE
PRI MUX
ELEC SYS FAIL
ENG ANTI ICE
VOICE CIPHER

CPG

MM01-024D

Figure 2-38. Pilot and CPG Caution / Warning Panels

Table 2-4. Pilot and CPG Master Caution/Warning Panel

Word Segment	Color	Illumination Parameter or Fault
MASTER CAUTION	AMBER	Alerts both crew members to scan both their master caution/warning panels and caution/warning panels to identify fault condition.
LOW RPM ROTOR	RED	N_R is less than 94 percent.
FIRE APU	RED	Fire has been detected in the APU area or aft deck area.
ENGINE 1 OUT	RED	N_P is below 94% or N_G is below 63% on No. 1 engine. (N_P disabled when power lever is not in FLY.)
ENGINE CHOP	RED	Both engines have been electrically retarded to idle power.
ENGINE 2 OUT	RED	N_P is below 94% or N_G is below 63% on No. 2 engine. (N_P disabled when power lever is not in FLY.)
HIGH RPM ROTOR	RED	N_R is more than 104 percent.
BUCS FAIL	RED	A component within the BUCS system has failed.
PRESS TO TEST	WHITE	When depressed, all master caution/warning panel and caution/warning panel segments, plus all other advisory lights, are illuminated within that crew station for test.

Table 2-5. Pilot Caution/Warning Lights

Word Segment	Color	Illumination Parameter or Fault
IFF	RED	Mode 4 is not able to respond to interrogation.
ENG ICE	AMBER	Ice forming on No. 1 engine ice detector probe.
BUCS ON	AMBER	Backup control system is activated in at least one control axis.
CHIPS ENG 1	AMBER	No. 1 engine scavenge oil contains metal fragments.
OIL PSI ENG 1	AMBER	No. 1 engine oil pressure is below 25 psi.
OIL BYP ENG 1	AMBER	No. 1 engine oil filter is clogged, and bypass has begun.
FUEL BYP ENG 1	AMBER	No. 1 engine fuel filter is clogged, and bypass has begun.
FUEL PSI ENG 1	RED	No. 1 engine fuel pressure is less than 9 psi.
	AMBER	Spare

Table 2-5. Pilot Caution/Warning Lights (cont)

Word Segment	Color	Illumination Parameter or Fault
ROCKET	AMBER	Failed system.
MISSILE	AMBER	Failed system.
RTR BK	AMBER	Rotor brake switch is in BRAKE/LOCK position.
MAN STAB	AMBER	Automatic operation of the stabilator control unit has failed, or manual control has been selected.
CHIPS NOSE GRBX 1	AMBER	No. 1 engine nose gearbox oil contains metal fragments.
OIL PSI NOSE GRBX 1	AMBER	No. 1 engine nose gearbox oil pressure is below 26-30 psi.
OIL HOT NOSE GRBX 1	AMBER	No. 1 engine nose gearbox oil temperature is above 274° -294°F. (135° - 145°C)
BLADE ANTI ICE FAIL	AMBER	Failed system.
CANOPY ANTI ICE FAIL	AMBER	Canopy temperature has exceeded limits.
ENG 1 ANTI ICE	AMBER	No. 1 engine anti-ice subsystem has failed.
ENG 2 ANTI ICE	AMBER	No. 2 engine anti-ice subsystem has failed.
GUN	AMBER	Failed system.
TADS	AMBER	Failed system.
PNVS	AMBER	Failed system.
PRI HYD PSI	AMBER	Primary system hydraulic oil pressure is below 1250 psi.
OIL LOW PRI HYD	AMBER	Primary system hydraulic fluid is at minimum operating level.
OIL BYP PRI HYD	AMBER	A pressure differential of 60 to 80 psid has been detected in either the pressure or return filter of the primary hydraulic system. The return filter will bypass; the pressure filter will not.
OIL PSI MAIN XMSN 1	AMBER	Main transmission No. 1 system pressure is below 26-30 psi.

Table 2-5. Pilot Caution/Warning Lights (cont)

Word Segment	Color	Illumination Parameter or Fault
OIL HOT MAIN XMSN 1	AMBER	Main transmission No. 1 oil system temperature is above 274° 294°F. (135° - 145°C)
GEN 1	AMBER	No. 1 generator is not on line.
RECT 1	AMBER	Transformer-rectifier has failed, or there is no ac input to the rectifier.
HOT RECT 1	AMBER	Temperature 190°F (87°C) at transformer-rectifier is excessive. Rectifier fan has probably failed.
SHAFT DRIVEN COMP	AMBER	Shaft driven compressor oil temperature is above 340° – 360°F (171° – 182°C); or shaft driven compressor pressurized air output is less than 5-9 psi. No 1 engine bleed air will automatically supply the pressurized air system if No. 1 engine is operating.
PRI MUX	AMBER	The selected multiplex bus controller has malfunctioned and the other bus controller has assumed control of the multiplex bus. Light will extinguish when the operating bus controller is selected with the MUX switch on the CPG Fire Control Panel.
UTIL HYD PSI	AMBER	Utility system hydraulic oil pressure is below 1250 psi.
OIL LOW UTIL HYD	AMBER	Utility system hydraulic fluid is at minimum operating level.
OIL BYP UTIL HYD	AMBER	A pressure differential of 60 to 80 psid has been detected in either the pressure or return filter of the utility hydraulic system. The return filter will bypass; the pressure filter will not.
OIL PSI MAIN XMSN 2	AMBER	Main transmission No. 2 oil system pressure is below 26-30 psi.
OIL HOT MAIN XMSN 2	AMBER	Main transmission No. 2 oil system temperature is above 274° – 294°F. (135° - 145°C)
GEN 2	AMBER	No. 2 generator is not on line.
RECT 2	AMBER	Transformer-rectifier has failed, or there is no ac input to the rectifier.
HOT RECT 2	AMBER	Temperature 190°F (87°C) at transformer-rectifier is excessive. Rectifier fan has probably failed.
CANOPY	AMBER	Canopy doors are not properly closed.
EXT PWR	AMBER	Access door to external power receptacle is open.

Table 2-5. Pilot Caution/Warning Lights (cont)

Word Segment	Color	Illumination Parameter or Fault
HOT BAT	AMBER	Battery temperature is in excess of 134°F (57°C), or a defective cell has been detected. Battery charging is discontinued.
CHARGER	AMBER	Charger has failed to charge during a programmed charging cycle.
CHIPS MAIN XMSN	AMBER	Main transmission chip detector has detected metal fragments.
TEMP TR	AMBER	Tail rotor gearbox temperature is above 274° -294°F. (135°-145°C)
CHIPS NOSE GRBX 2	AMBER	No. 2 engine nose gearbox oil contains metal fragments.
OIL PSI NOSE GRBX 2	AMBER	No. 2 engine nose gearbox oil pressure is below 26-30 psi.
OIL HOT NOSE GRBX 2	AMBER	No. 2 engine nose gearbox oil temperature is above 274° -294°F. (135°-145°C)
ASE	AMBER	One or more components of the automatic stabilization equipment is inoperative; one or more of the SAS channels is inoperative or has been selected OFF.
FUEL LOW FWD	AMBER	When light comes on, about 260 to 300 pounds of fuel remains in forward fuel cell at cruise attitude.
FUEL LOW AFT	AMBER	When light comes on, about 210 to 270 pounds of fuel remains in aft fuel cell at cruise attitude.
EXT EMP	AMBER	All external fuel tanks are empty.
REFUEL VALVE OPEN	AMBER	Refuel valve is open.
OIL PSI ACC PUMP	AMBER	Main transmission accessory gearbox oil pressure is below 26-30 psi.
TEMP INT	AMBER	Intermediate gearbox temperature is above 274° -294°F. (135°-145°C)
CHIPS ENG 2	AMBER	No. 2 engine scavenge oil contains metal fragments.
OIL PSI ENG 2	AMBER	No. 2 engine oil pressure is below 25 psi.
OIL BYP ENG 2	AMBER	No. 2 engine oil filter is clogged, and bypass has begun.
FUEL BYP ENGINE 2	AMBER	No. 2 engine fuel filter is clogged, and bypass has begun.

Table 2-5. Pilot Caution/Warning Lights (cont)

Word Segment	Color	Illumination Parameter or Fault
FUEL PSI ENG 2	RED	No. 2 engine fuel pressure is less than 9 psi.
ECS	AMBER	The overheat sensor has sensed a mixed air FAB temperature greater than 105°F (41°C).
APU ON	AMBER	APU operation when APU N_G speed is above 95 percent.
APU FAIL	AMBER	Indicates one of the following: APU thermocouple malfunction, overtemperature, overspeed, low APU oil pressure, or overcurrent.
VIB GRBX	AMBER	Intermediate or tail rotor gearbox vibration level is excessive.
FUEL XFR	AMBER	Fuel transfer pump is selected but not operating.
ADS	AMBER	Failed system.
BOOST PUMP ON	AMBER	Boost pump operation is on and providing 8 to 10 psi in fuel line to fuel filter.
RDR JAM	AMBER	AN/ALQ 136 has failed, is off, or is in a warm-up cycle.
IR JAM	AMBER	AN/ALQ 144 has failed, or is in warm-up/cool-down cycle.

Table 2-6. Copilot/Gunner Caution/Warning Lights

Word Segment	Color	Illumination Parameter or Fault
IFF	RED	Mode 4 is not able to respond to interrogation.
ENG 1	AMBER	One or a combination of the following: engine oil pressure low, engine oil filter in bypass, engine chips, engine fuel filter bypass, engine fuel pressure low, nose gearbox chips, nose gearbox oil pressure low, nose gearbox oil temperature high.
MAIN XMSN 1	AMBER	One or combination of the following: transmission oil temperature high, oil pressure low.
GUN	AMBER	Failed system.
ROCKET	AMBER	Failed system.
ELEC SYS FAIL	RED	Complete dc electrical system failure. The battery is powering the dc emergency bus.
BUCS ON	AMBER	Backup control system is activated in at least one control axis.
MISSILE	AMBER	Failed system.

Table 2-6. Copilot/Gunner Caution/Warning Lights (cont)

Word Segment	Color	Illumination Parameter or Fault
TADS	AMBER	Failed system.
PRI HYD	AMBER	Primary system hydraulic oil pressure is below 1250 psi.
MAN STAB	AMBER	Automatic operation of the stabilator control unit has failed, or manual control has been selected.
TEMP INT	AMBER	Intermediate gearbox temperature is above 274° -294°F. (135°-145°C)
UTIL HYD	AMBER	Utility system hydraulic oil pressure is below 1250 psi.
ENG ANTI ICE	AMBER	An engine anti-ice subsystem has failed.
VOICE CIPHER	AMBER	KY-58 is operating.
CHIPS MAIN XMSN	AMBER	Main transmission chip detector has detected metal fragments.
FUEL LOW FWD	AMBER	When light comes on, about 260 to 300 pounds of fuel remain in the forward fuel cell at cruise attitude.
FUEL LOW AFT	AMBER	When light comes on, about 210 to 270 pounds of fuel remain in the aft fuel cell at cruise attitude.
ASE	AMBER	One or more components of the automatic stabilization equipment is inoperative, or one or more of the SAS channels is inoperative or has been selected OFF.
ENG 2	AMBER	One or a combination of the following: engine oil pressure low, engine oil filter in bypass, engine chips, engine fuel filter bypass, engine fuel pressure low, nose gearbox chips, nose gearbox oil pressure low, nose gearbox oil temperature high.
MAIN XMSN 2	AMBER	One or a combination of the following: transmission oil temperature high, oil pressure low.
PRI MUX	AMBER	The selected bus controller has malfunctioned and the other bus controller has assumed control of the multiplex bus. Light will extinguish when the operating bus controller is selected with the MUX switch on the CPG Fire Control Panel.
VIB GRBX	AMBER	Intermediate or tail rotor gearbox vibration level is excessive.
TEMP TR	AMBER	Tail rotor gearbox temperature is above 274° -294°F. (135°-145°C)
FUEL XFER	AMBER	TRANS switch is set TO FWD or TO AFT and the forward fuel cell is full.
ADS	AMBER	Failed system.

2-121. Vertical Speed Indicators (VSI).

A VSI in each crew station (figure 2-9 and 2-10) measures the rates of change in static air pressure resulting from climbs and descents. An adjustment screw on the lower left corner is used to zero the pointer, if necessary, prior to flight.

2-122. Airspeed Indicators.

An airspeed indicator in each crew station (figure 2-9 and 2-10) measures the difference between pitot pressure and static pressure. Instrument range markings and limitations are contained in Chapter 5, Section II, System Limits. At low airspeeds and high power settings, indicated airspeeds may be unreliable and fluctuate greater than 10 KIAS.

2-123. Attitude Indicators.

Attitude indicators are installed in both crew stations. There are, however, differences in performance and operation.

a. **Pilot Standby Attitude Indicator**. The pilot instrument provides an independent backup display of helicopter attitude in case the primary power or flight reference system fails. It is powered by 28 vdc power from the emergency bus. The indicator can display 360 degrees of roll and ±85 degrees of pitch. A PULL TO CAGE knob at the lower right corner has two functions. Pulling it out with power applied to the instrument will cage the motor-driven internal gyroscope. The knob may be turned to adjust the pitch of the artificial horizon relative to the fixed aircraft symbol.

b. **Copilot/Gunner Remote Attitude Indicator**. The CPG remote attitude indicator (RAI) displays helicopter attitude from information obtained from the heading and attitude reference system (HARS). It requires 115-vac 400-Hz power for normal operation. The indicator can display 360 degrees of roll and ±90 degrees of pitch. HARS input will drive roll and/or pitch servos, which results in the appropriate roll or pitch of the artificial horizon. If HARS input ceases or becomes unreliable, 28-vdc power will cause an OFF flag to appear at the window on the left side of the instrument face. A pitch trim knob at the lower right corner may be turned to adjust the pitch of the artificial horizon relative to the fixed aircraft reference symbol.

2-124. Headset Audio Warning System.

In addition to the visual cues to help crewmembers identify faults, auditory signals are provided as an aid in rapid recognition of critical conditions. These audio cues are described in table 2-7.

Table 2-7. Audio Warning Signals

Signal	Tone
Engine Out	Rising frequency
Rotor RPM Low	Rising frequency
■ STAB FAIL	Steady Tone
IFF	Steady, amplitude modulated
Missile Alert	Falling frequency
■ APR-39 Alert	Dependent on threat radar

Section XV. SERVICING, PARKING, MOORING

2-125. SERVICING.

Servicing information and procedures for the various systems or components are covered in paragraphs 2-125 through 2-139. Servicing points for fuel, engine oil, main transmission oil, nose gearbox, and auxiliary power unit oil are illustrated in figure 2-39. Fuel, lubricants, specifications, and fuel capacities are listed in table 2-8.

a. **Fuel types**. Fuels are classified as primary, commercial equivalent, or emergency, as follows:

(1) Primary fuels are JP-4, JP-5 and JP-8.

(2) Commercial equivalent fuels are found in table 2-9.

(3) Emergency Fuels. None authorized.

b. **Use of Fuels**. There is no special limitation on the use of primary fuel, but limitations in table 2-9 apply when commercial fuels are used. For the purpose of recording, fuel mixtures shall be identified as to the major component of the mixture.

c. **Interchangeable Fuels**. Fuels having the same NATO code number are interchangeable. Jet fuels (table 2-9) conforming to specification ASTM D-1655 may be used when MIL-T-5624 fuels are not available. This usually occurs during cross-country flights where aircraft using NATO F-40 (JP-4) are refueled with NATO F-44 (JP-5) or commercial ASTM type A fuels. Whenever this occurs, the engine operating characteristics may change because of lower operating temperatures. Slower acceleration, lower engine speed, harder starting, and greater range may be experienced. The reverse is true when changing from F-44 (JP-5) fuel to F-40 (JP-4) or commercial ASTM type B fuels.

d. **Mixing of Fuels**. When changing from one type of authorized fuel to another, for example: JP-4 to JP-5, it is not necessary to drain the fuel system before adding new fuel.

e. **Oil types**. Oils are classified as primary, commercial equivalent, or emergency as follows:

(1) Primary oils.

(2) Commercial equivalent oils are found in table 2-10.

(3) Emergency oils – None authorized.

2-126. Fuel System Servicing.

The helicopter has two crash-resistant self-sealing fuel cells located forward and aft of the ammunition bay in the center fuselage section. Each cell is serviced through gravity filler receptacles or pressure-filled through closed-circuit or single-point adapters (figure 2-39). Provisions are also made for as many as four external auxiliary fuel tanks to be carried on the stores pylons. Table 2-8 lists individual tank capacities.

WARNING

When opening anti-syphoning device on external tank flapper valve, extreme care should be exercised when releasing air pressure to preclude venting of fuel overboard through filler neck.

a. **Gravity Refueling**. For gravity refueling, open fuel vent shutoff valve, remove filler cap, pull chain (opening anti-syphoning device), and using correct fuel, service cells to the required level (table 2-8).

b. **Closed-Circuit Pressure Refueling**. Using service instructions (figure 2-39) printed on the inside panel of the refuel panel access door, perform pressure refueling precheck. Remove adapter cap, and using standard Army nozzle, service fuel cells with correct fuel to the required level (table 2-8). Using the standard Army nozzle, fuel flow at 15 psi is 56 gallons per minute.

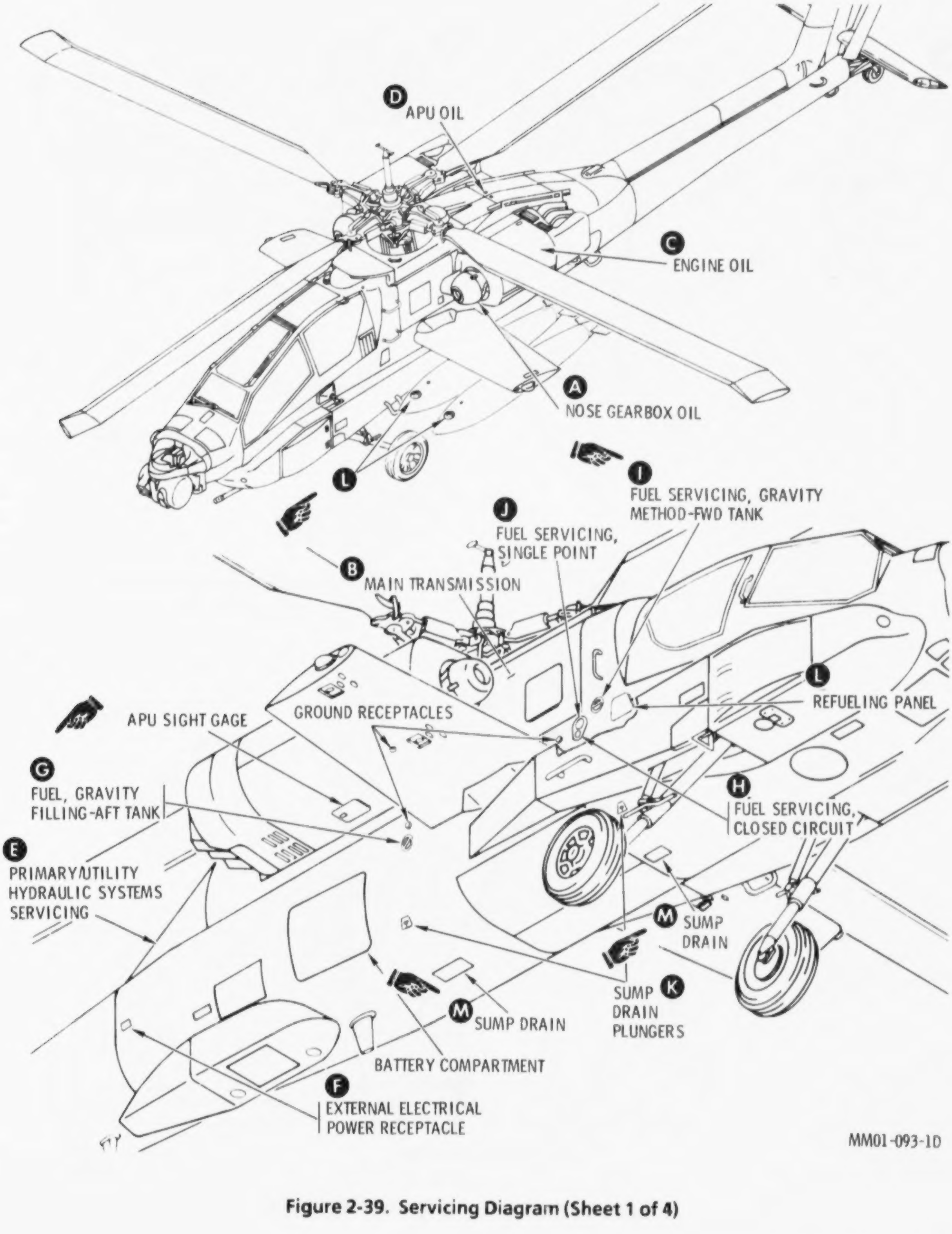
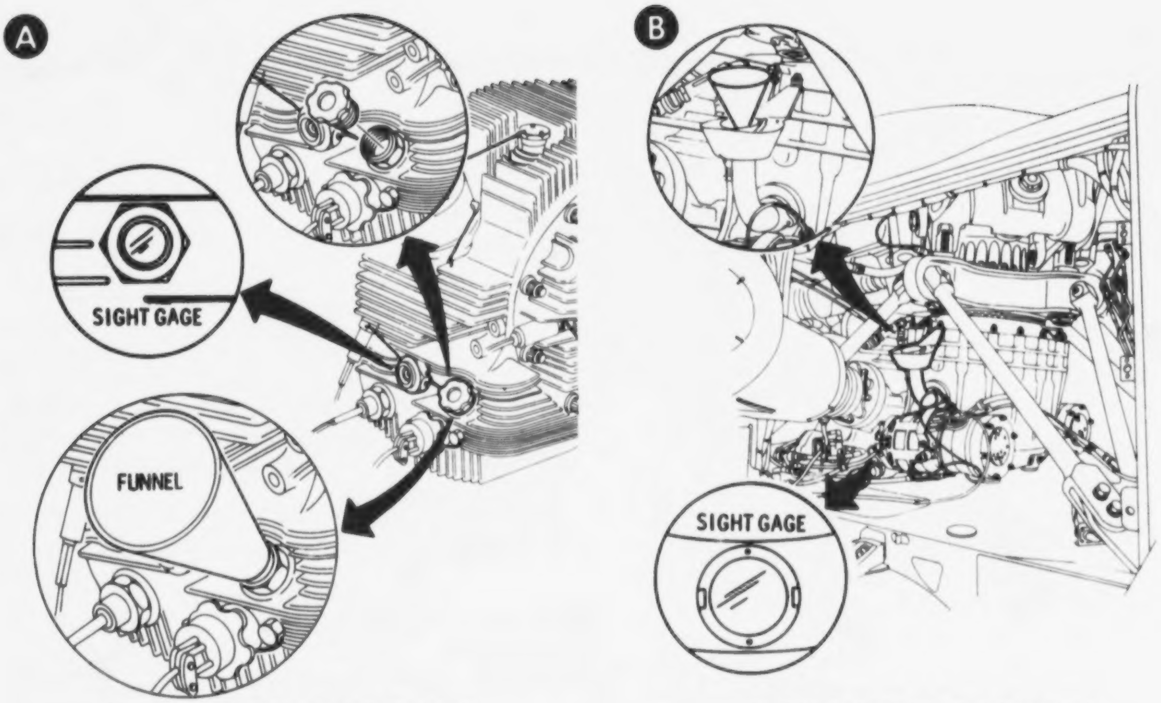
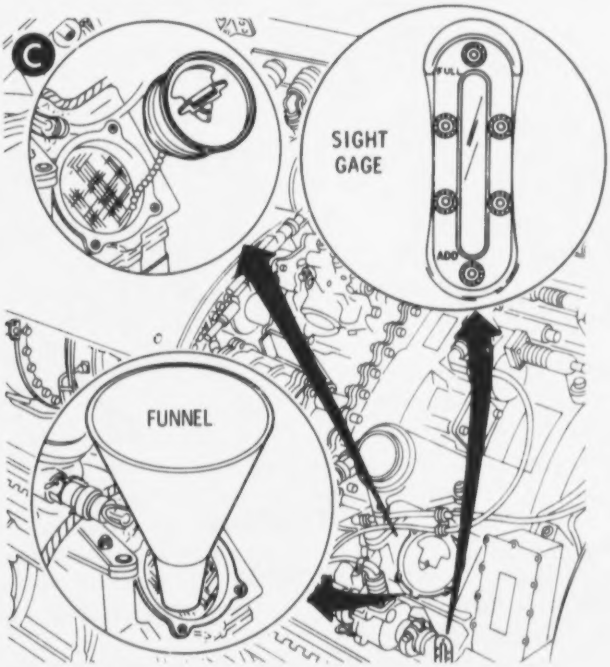

D APU OIL
C ENGINE OIL
A NOSE GEARBOX OIL
L
I FUEL SERVICING, GRAVITY METHOD-FWD TANK
J FUEL SERVICING, SINGLE POINT
B MAIN TRANSMISSION
L REFUELING PANEL
APU SIGHT GAGE
GROUND RECEPTACLES
G FUEL, GRAVITY FILLING-AFT TANK
H FUEL SERVICING, CLOSED CIRCUIT
E PRIMARY/UTILITY HYDRAULIC SYSTEMS SERVICING
M SUMP DRAIN
K SUMP DRAIN PLUNGERS
M SUMP DRAIN
BATTERY COMPARTMENT
F EXTERNAL ELECTRICAL POWER RECEPTACLE
MM01-093-1D

Figure 2-39. Servicing Diagram (Sheet 1 of 4)


A
SIGHT GAGE
FUNNEL
B
SIGHT GAGE

OIL SERVICING-ENGINE NOSE GEARBOX

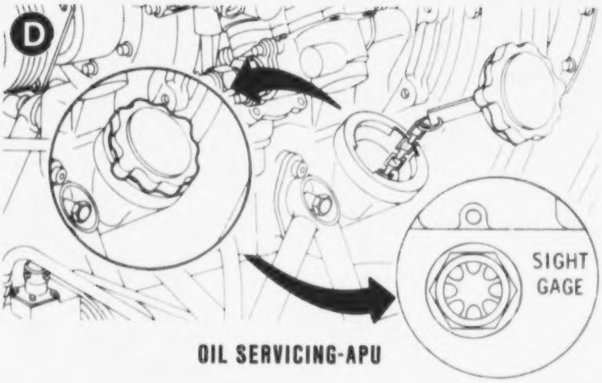
OIL SERVICING-MAIN TRANSMISSION


C
SIGHT GAGE
FULL
ADD
FUNNEL

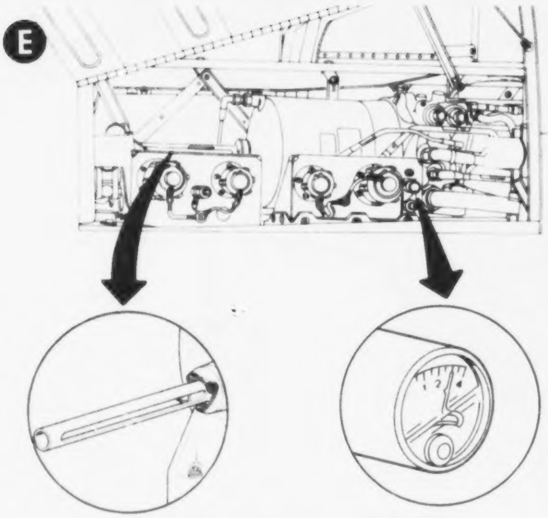
OIL SERVICING-ENGINE

MM01-093-2C

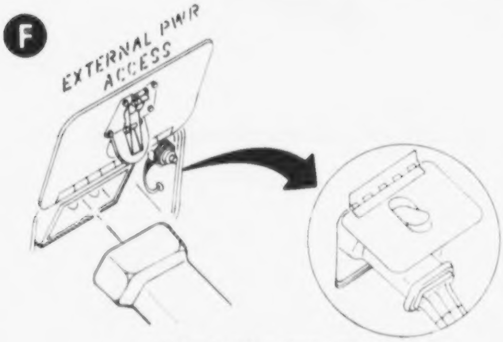
Figure 2-39. Servicing Diagram (Sheet 2 of 4)


D
SIGHT GAGE

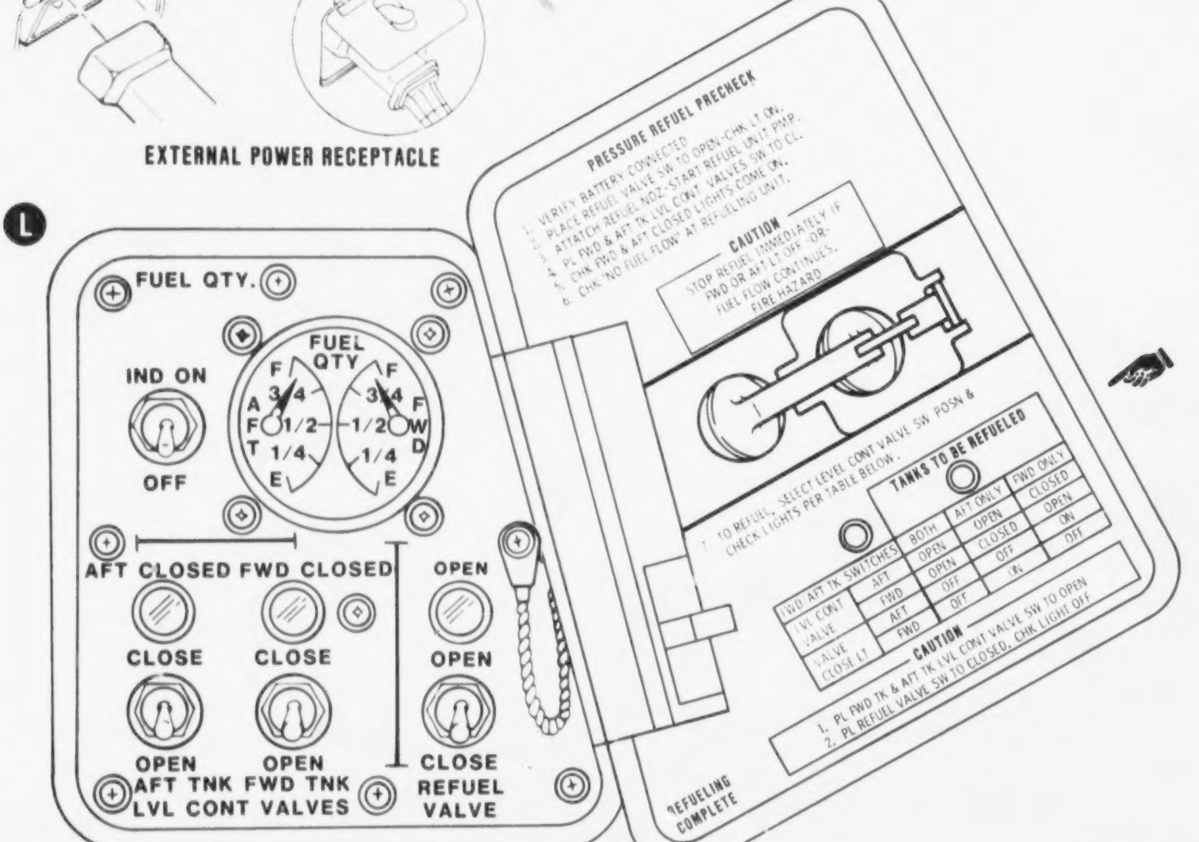
OIL SERVICING-APU



OIL SERVICING-HYDRAULIC


F
EXTERNAL PWR ACCESS

EXTERNAL POWER RECEPTACLE


L
FUEL QTY.
IND ON
OFF
FUEL QTY
F
3/4
1/2
1/4
E
AFT
FWD
AFT CLOSED
FWD CLOSED
OPEN
CLOSE
CLOSE
OPEN
OPEN
OPEN
CLOSE
AFT TNK LVL CONT
FWD TNK VALVES
REFUEL VALVE
REFUELING COMPLETE

PRESSURE REFUEL PRECHECK

1. VERIFY BATTERY CONNECTED
2. PLACE REFUEL VALVE SW TO OPEN-CHK LT ON.
3. ATTATCH REFUEL NOZ-START REFUEL UNIT PMP.
4. PL FWD & AFT TK LVL CONT VALVES SW TO CL.
5. CHK FWD & AFT CLOSED LIGHTS COME ON.
6. CHK 'NO FUEL FLOW' AT REFUELING UNIT.

CAUTION

STOP REFUEL IMMEDIATELY IF FWD OR AFT LT OFF -OR- FUEL FLOW CONTINUES. FIRE HAZARD

7. TO REFUEL, SELECT LEVEL CONT VALVE SW POSN & CHECK LIGHTS PER TABLE BELOW.

		TANKS TO BE REFUELED		
FWD AFT TK SWITCHES		BOTH	AFT ONLY	FWD ONLY
LVL CONT VALVE	AFT	OPEN	OPEN	CLOSED
	FWD	OPEN	CLOSED	OPEN
VALVE CLOSE LT	AFT	OFF	OFF	ON
	FWD	OFF	ON	OFF

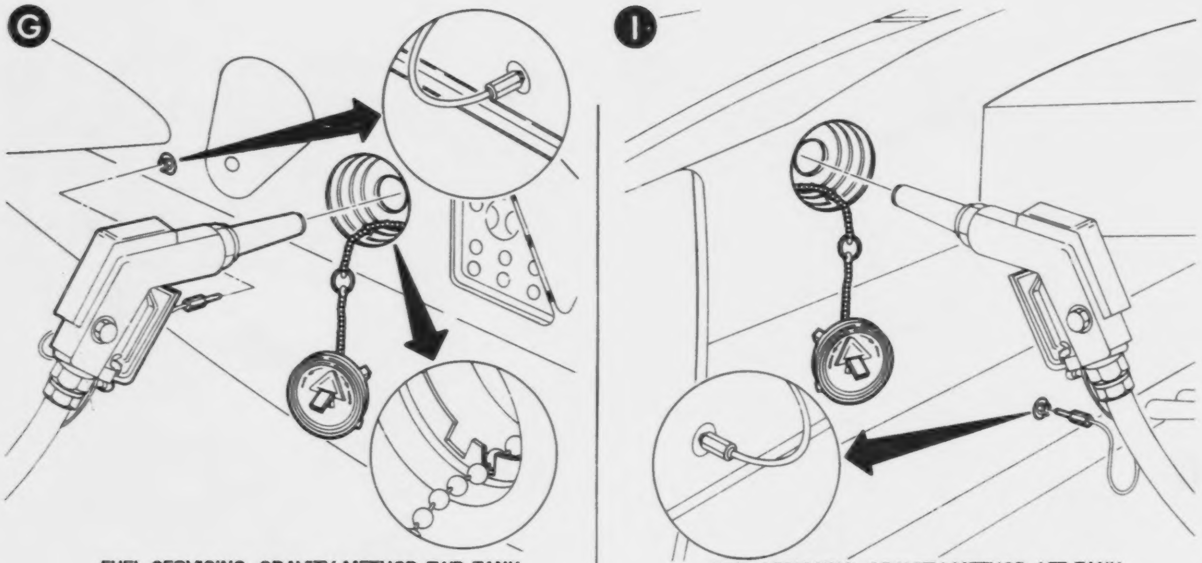
CAUTION

1. PL FWD TK & AFT TK LVL CONT VALVE SW TO OPEN
2. PL REFUEL VALVE SW TO CLOSED. CHK LIGHT OFF

REFUELING PANEL

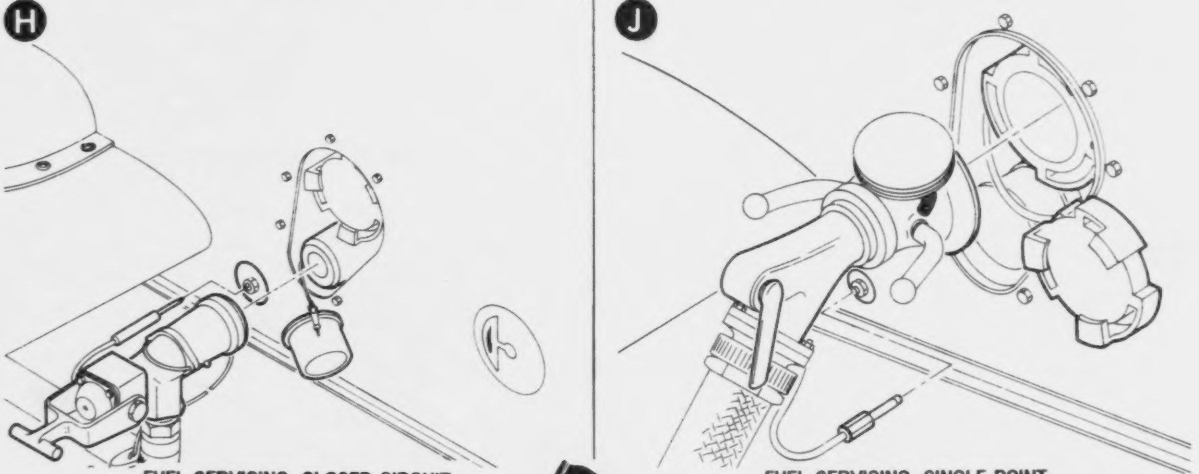
MM01-093-3D

Figure 2-39. Servicing Diagram (Sheet 3 of 4)



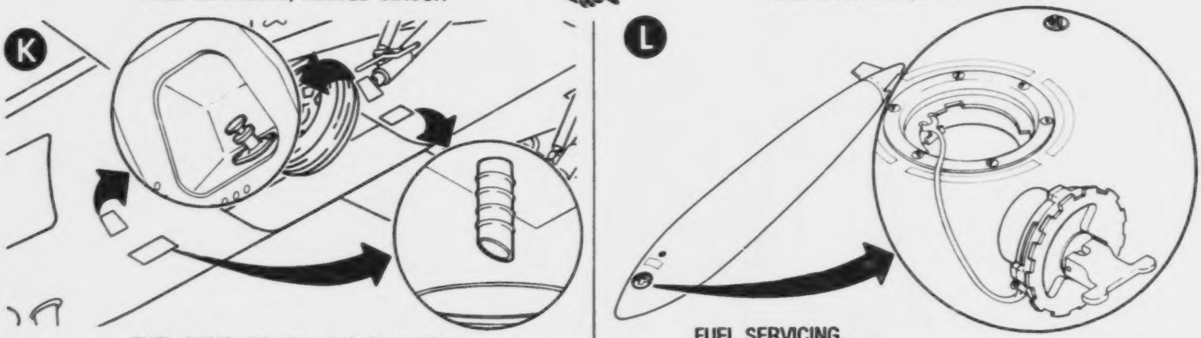
FUEL SERVICING, GRAVITY METHOD-FWD TANK

FUEL SERVICING, GRAVITY METHOD-AFT TANK



FUEL SERVICING, CLOSED CIRCUIT

FUEL SERVICING, SINGLE POINT



FUEL SUMP, DRAINS AND PLUNGER

FUEL SERVICING,
GRAVITY METHOD-EXTERNAL TANK

Figure 2-39. Servicing Diagram (Sheet 4 of 4)

Table 2-8. Fuel and Lubricant Specifications and Capacities

Tank or System	Capacity US	Name	Materials Spec	Grade
Forward Fuel Cell	156 gal usable 156 gal total	Turbine Fuel	MIL-T-5624 *MIL-T-5624 MIL-T-83133	JP-4 JP-5 JP-8
Aft Fuel Cell	219 gal usable 220 gal total	Turbine Fuel	MIL-T-5624 *MIL-T-5624 MIL-T-83133	JP-4 JP-5 JP-8
Auxiliary Fuel Tank	229 gal usable 230 gal total (each tank)	Turbine Fuel	MIL-T-5624 *MIL-T-5624 MIL-T-83133	JP-4 JP-5 JP-8
Engine Oil		Lubricating Oil	*MIL-L-23699 MIL-L-7808	
Main Transmission		Lubricating Oil	*MIL-L-23699 MIL-L-7808	
Engine Nose Gearbox		Lubricating Oil	*MIL-L-23699 MIL-L-7808	
Auxiliary Power Unit (APU)		Lubricating Oil	*MIL-L-23699 MIL-L-7808	
Primary Hydraulic System		Hydraulic Fluid	*MIL-H-83282 MIL-H-5606	
Utility Hydraulic System		Hydraulic Fluid	*MIL-H-83282 MIL-H-5606	
Main Landing Gear Shock Strut		Hydraulic Fluid	MIL-H-5606	
Tail Landing Gear Shock Strut		Hydraulic Fluid	MIL-H-5606	
Brake System		Hydraulic Fluid	MIL-H-5606	

*Do not use in ambient temperatures below -25°F (-32°C).
Do not mix lubricating oils MIL-L-23699 and MIL-L-7808.
Do not mix hydraulic fluids MIL-H-83282 and MIL-H-5606.

Table 2-9. Approved Fuels

US Military Fuel NATO Code No.	JP-4 (MIL-T-5624) F-40 (Wide Cut Type)	JP-5 (MIL-T-5624) or JP-8 (MIL-T-83133) F-44 or F-43 (High Flash Type)	
COMMERCIAL FUEL (ASTM-D-1655)	JET B	JET A	JET A-1 NATO F-34
American Oil Co.	American JP-4	American Type A	
Atlantic Richfield	Arcojet B	Arcojet A	Arcojet A-1
Richfield Div		Richfield A	Richfield A-1
B.P. Trading	B.P.A.T.G.		B.P.A.T.K
Caltex Petroleum Corp.	Caltex Jet B		Caltex Jet A-1
Cities Service Co.		CITGO A	
Continental Oil Co.	Conoco JP-4	Conoco Jet-50	Conoco Jet-60
Gulf Oil	Gulf Jet B	Gulf Jet A	Gulf Jet A-1
EXXON Co. USA	EXXON Turbo Fuel B	EXXON A	EXXON A-1
Mobil Oil	Mobil Jet B	Mobil Jet A	Mobil Jet A-1
Phillips Petroleum	Philjet JP-4	Philjet A-50	
Shell Oil	Aeroshell JP-4	Aeroshell 640	Aeroshell 650
Sinclair		Superjet A	Superjet A-1
Standard Oil Co.		Jet A. Kerosene	Jet A-1 Kerosene
Chevron	Chevron B	Chevron A-50	Chevron A-1
Texaco	Texaco Avjet B	Avjet A	Avjet A-1
Union Oil	Union JP-4	76 Turbine Fuel	
FOREIGN FUEL	NATO F-40	NATO F-44	
Belgium	BA-PF-2B		
Canada	3GP-22F	3-6P-24e	
Denmark	JP-4 MIL-T-5624		
France	Air 3407A		
Germany (West)	VTL-9130-006	UTL-9130-0007/UTL 9130-010	
Greece	JP-4 MIL-T-5624		
Italy	AA-M-C-1421	AMC-143	
Netherlands	JP-4 MIL-T-5624	D. Eng RD 2493	
Norway	JP-4 MIL-T-5624		
Portugal	JP-4 MIL-T-5624		
Turkey	JP-4 MIL-T-5624		
United Kingdom (Britain)	D. Eng RD 2454	D. Eng RD 2498	

NOTE: COMMERCIAL FUEL LIMITATIONS

Anti-icing and Biocidal Additive for Commercial Turbine Engine Fuel. The additive provides anti-icing protection and functions as a biocide to kill microbial growths in aircraft fuel systems. Icing inhibitor conforming to MIL-I-27686 shall be added to commercial fuel, not containing an icing inhibitor, during refueling operations, regardless of ambient temperatures. Refueling operations shall be accomplished in accordance with accepted commercial procedures. This additive (Prist or eq.) is not available thru the Army Supply System, but is to be locally procured when needed.

Table 2-10. Approved Oils

Approved Domestic Commercial Oils For MIL-L-7808

Manufacturer's Name	Manufacturer's Designation
American Oil and Suply Co.	PQ Turbine Oil 8365
Humble Oil and Refining Co.	ESSO/ENCO Turbo Oil 2389
Mobile Oil Corp.	RM-184A/RM-201A

Approved Domestic Commercial Oils for MIL-L-23699

Manufacturer's Name	Manufacturer's Designation
Americal Oil and Supply Co.	PQ Turbine Lubricant 5247/ 6423/6700/7731/8878/9595
Bray Oil Co.	Brayco 899/899-G/899-S
Castrol Oil Co.	Castrol 205
Chevron International Oil Co., Inc.	Jet Engine Oil 5
Crew Chemical Corp.	STO-21919/STO-21919A/STD 6530
W.R. Grace and Co. (Hatco Chemical Div.)	HATCOL 3211/3611
Humble Oil and Refining Co.	Turbo Oil 2380 (WS-6000)/2395 (WS-6495)/2392/2393
Mobile Oil Corp.	RM-139A/RM-147A/Avrex S Turbo 260/Avrex S Turbo 265
Royal Lubricants Co.	Royco 899 (C-915)/899SC/ Stauffer Jet II
Shell Oil Co., Inc.	Aeroshell Turbine Oil 500
Shell International Petroleum Co., Ltd.	Aeroshell Turbine Oil 550
Standard Oil Co., of California	Chevron Jet Engine Oil 5
Stauffer Chemical Co.	Stauffer 6924/Jet II
Texaco, Inc.	SATO 7377/7730 TL-8090

Approved Foreign Commercial Oils for MIL-L-7808

Data not available at this time.

Approved Foreign Commercial Oils for MIL-L-23699

Data not available at this time.

c. **Single-Point Pressure Refueling**. Using service instruction (figure 2-39) printed on the inside panel of the refuel panel access door, perform pressure refueling precheck. Remove adapter cap, and using an Army supplied SPA nozzle, fill fuel cells with correct fuel to the required level (table 2-8). With the SPA nozzle, fuel flow at 50 psi is at least 100 gallons per minute.

d. **Refueling of External Auxiliary Tanks**. The external auxiliary tanks are gravity-filled through filler receptacles. Remove the gravity filler caps and service tanks with correct fuel to the required levels (table 2-8).

e. **Fuel Sump Drains**. Two fuel sump drains (detail K, figure 2-39), one for each tank, are located on the underside of the fuselage. They are used to drain fuel or water and to check for fuel contamination. To actuate, press the plunger. Hold until sufficient fuel has been drained.

2-127. Rapid Refueling.

The helicopter is refueled for rapid turn-around with the No. 2 engine shut down and rotors turning. The following additional precautions must be observed for rapid refueling:

a. Pilot and CPG must perform their armament safety check prior to entering the Forward Area Refueling Point (FARP).

b. Radio transmissions must be limited to emergencies ONLY until refueling has been completed.

c. When fueling is completed, the pilot must check that his REFUEL VALVE OPEN caution/warning panel light is out.

d. Prior to departure, ground personnel must advise the pilot that fuel caps are installed and grounding cables are removed.

2-128. Engine Oil System Servicing.

The engine oil tank is located in the engine frame. It is serviced through a gravity filler port. An oil-level sight gage is located near the gravity filler port. When the oil level falls to the add mark, replenish with correct oil (table 2-8) until the level reaches the full mark on the sight gage.

2-129. Main Transmission Servicing.

The main transmission is located below the main rotor static mast base in the center fuselage section. Access to the oil filler cap and the right sump oil-level sight gage is through the transmission access panel on the right side of the fuselage (figure 2-1). The left sump oil level sight gage can be viewed through the transmission access door on the left side of the fuselage (figure 2-1).

Add oil to the proper service level. Table 2-8 lists the proper oil to use.

2-130. Auxiliary Power Unit (APU) Servicing.

The APU oil filler cap and oil level sight gage are located on the oil reservoir on the APU gearbox (figure 2-34). The oil level can be viewed through the sight gage through an access panel under the No. 2 engine. Remove the oil filler cap and add oil until the oil level reaches the proper service level. Table 2-8 lists the proper oil to use.

2-131. Nose Gearbox Servicing.

The engine nose gearboxes are mounted on the front of each engine (figure 2-39). When the oil falls below the proper service level, replenish with correct oil. Table 2-8 lists the correct oil to use.

2-132. Hydraulic System Servicing.

The hydraulic system should only be serviced (figure 2-39) with approved fluids from table 2-8. Detailed hydraulic system servicing instructions are in TM 55-1520-238-23.

2-133. Ground Air Source.

An external air receptacle (figure 2-40) under the No. 1 engine nacelle provides an attachment point for an external air line to start either engine or accomplish maintenance functions on the helicopter. An external air source that provides 40 psig and 30 pounds-per-minute air flow is required to pressurize the system for engine start. The maximum pressure from a ground source shall not exceed 50 psig.

2-134. Tire Servicing – Deleted.

2-135. PARKING.

Helicopter parking shall be in accordance with local directives and the following minimum procedures: station helicopter on as level a surface as possible; set wheel brakes; lock tail wheel; turn all switches off; disconnect external power; chock wheels; secure rotor blades; attach static ground wire, and install engine inlet, exhaust, and pitot covers.

2-136. Protective Covers.

Protective covers (figure 2-41) prevent damage from foreign objects and snow and water buildup to vital areas. All protective covers are part of the helicopter flyaway kit. The kit may be stored in the equipment stowage bay during flight. Covers are installed whenever the helicopter is on the ground for an extended period of time, or if severe environmental conditions such as ice or dust exist.

2-137. Towing the Helicopter.

The helicopter is towed by attaching a tow bar to the tail wheel fork. Towing the helicopter must be accomplished by trained personnel in accordance with instructions in TM 55-1520-238-23.

2-138. MOORING.

The helicopter is moored in accordance with TM 55-1520-238-23.

2-139. Canopy and Windshield Cleaning.

CAUTION

Do not attempt to clean either the PNVS or TADS turret windows or optics. These require special treatment by trained personnel.

The canopy and windshield should be carefully cleaned with clear water and a moist chamois or paper cleaning towel. Grease or oil spots should be removed with a paper cleaning towel moistened in an approved plastic cleaning agent.

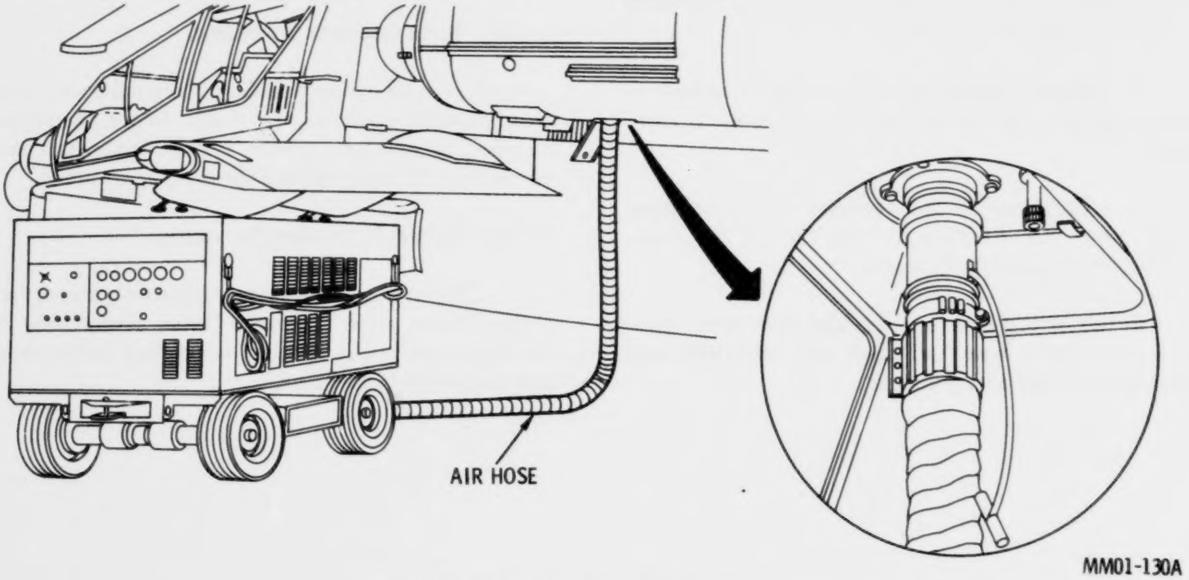


Figure 2-40. Ground Air Source

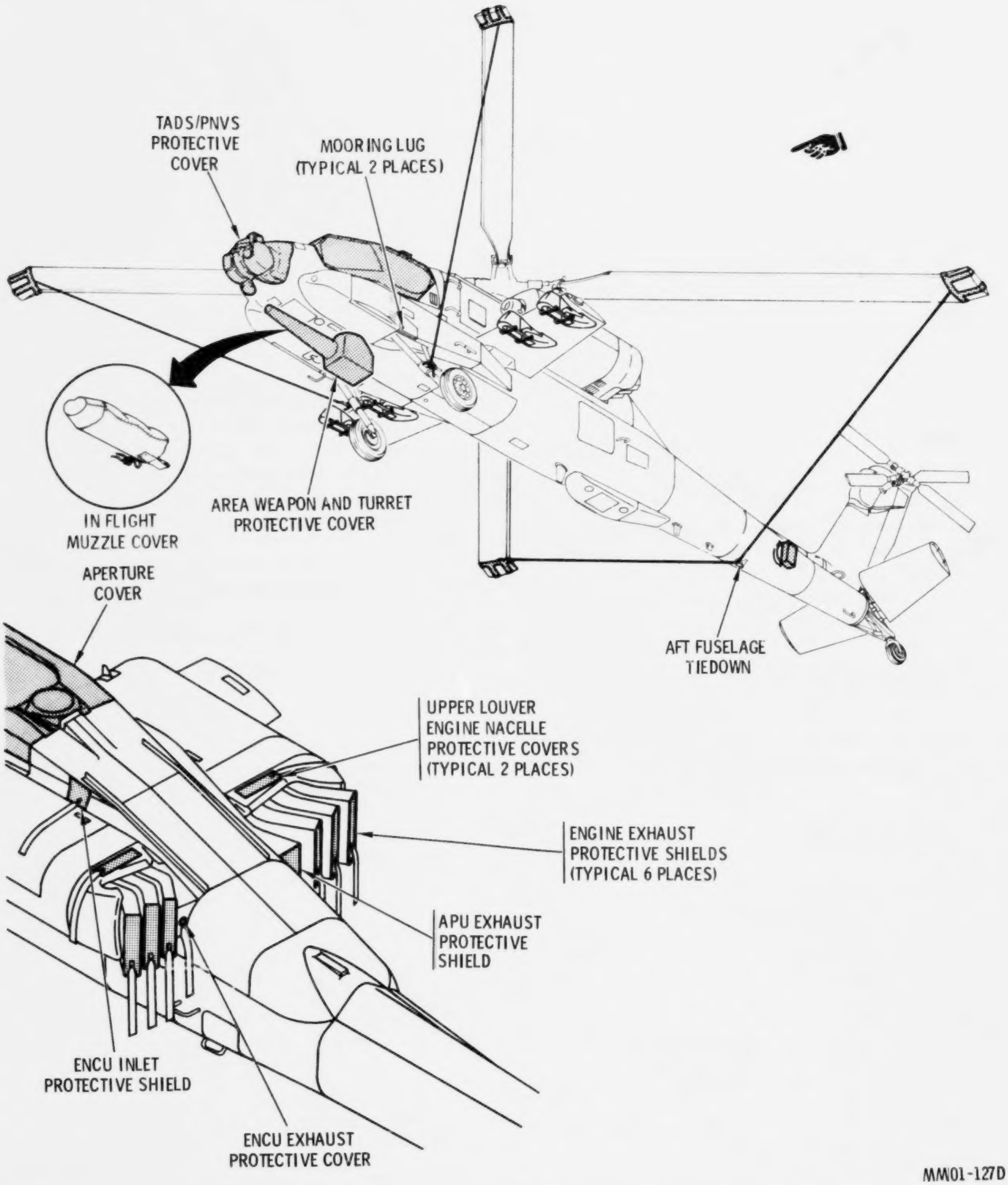

TADS/PNVS
PROTECTIVE
COVER
MOORING LUG
(TYPICAL 2 PLACES)
IN FLIGHT
MUZZLE COVER
AREA WEAPON AND TURRET
PROTECTIVE COVER
AFT FUSELAGE
TIEDOWN
APERTURE
COVER
UPPER LOUVER
ENGINE NACELLE
PROTECTIVE COVERS
(TYPICAL 2 PLACES)
ENGINE EXHAUST
PROTECTIVE SHIELDS
(TYPICAL 6 PLACES)
APU EXHAUST
PROTECTIVE
SHIELD
ENCU INLET
PROTECTIVE SHIELD
ENCU EXHAUST
PROTECTIVE COVER
MM01-127D

Figure 2-41. Protective Covers, Mooring, Towing (Sheet 1 of 2)

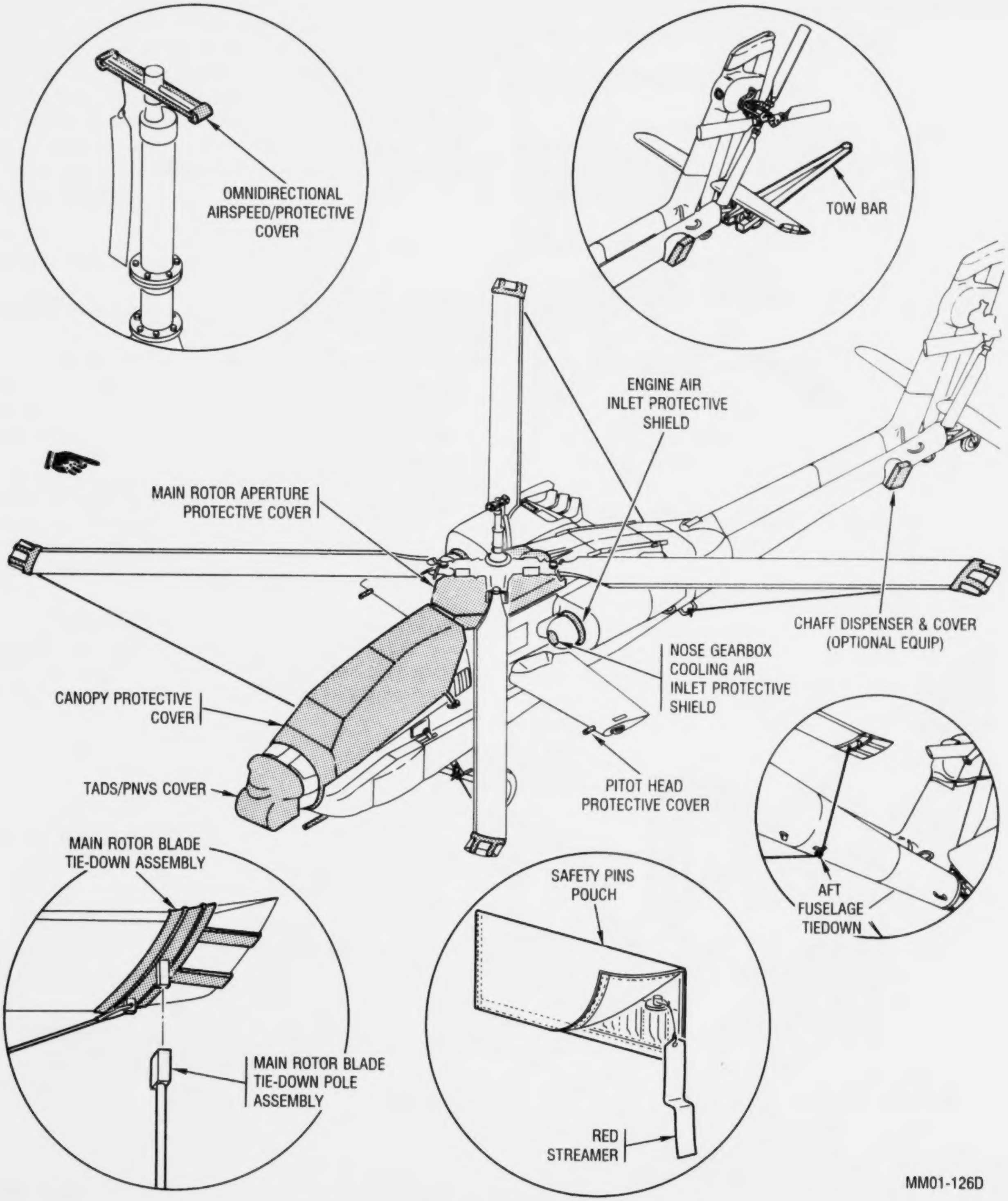

OMNIDIRECTIONAL AIRSPEED/PROTECTIVE COVER
TOW BAR
ENGINE AIR INLET PROTECTIVE SHIELD
MAIN ROTOR APERTURE PROTECTIVE COVER
CHAFF DISPENSER & COVER (OPTIONAL EQUIP)
NOSE GEARBOX COOLING AIR INLET PROTECTIVE SHIELD
CANOPY PROTECTIVE COVER
TADS/PNVS COVER
PITOT HEAD PROTECTIVE COVER
MAIN ROTOR BLADE TIE-DOWN ASSEMBLY
SAFETY PINS POUCH
AFT FUSELAGE TIEDOWN
MAIN ROTOR BLADE TIE-DOWN POLE ASSEMBLY
RED STREAMER
MM01-126D

Figure 2-41. Protective Covers, Mooring, Towing (Sheet 2 of 2)

CHAPTER 3

AVIONICS

SECTION I. GENERAL

3-1. DESCRIPTION.

The communications equipment provides VHF-AM/FM and UHF-AM capabilities. The navigation equipment includes LF-ADF and Doppler. Transponder equipment consists of an IFF receiver transmitter. Height above ground level is provided by a radar altimeter. Each antenna is described, with its major end item and respective locations, on the airframe (figure 3-1). Special avionics relating to mission accomplishment is discussed in Chapter 4.

3-2. Avionics Equipment Configuration.

Avionics equipment configurations are shown in Table 3-1.

3-3. Avionics Power Supply.

Power to operate most of the avionics equipment is provided by the emergency dc bus. This allows for backup battery power that is used in the event of a complete electrical failure. External power may also be applied. Function selector switches should be OFF before applying helicopter power.

3-4. Emergency Operation.

In the event of failure of both generators or both transformer-rectifiers, turn off all non-essential radio equipment to prevent excessive drain on the battery. The UHF radio set is equipped with a guard transmitter and receiver that operates on a fixed frequency of 243.000 MHz. The VHF radio set is equipped with a guard receiver that provides for reception of emergency transmissions on a fixed frequency of 121.500 MHz. The FM radio sets are equipped with a guard receiver that provides for reception of emergency transmissions on a fixed frequency of 40.50 MHz.

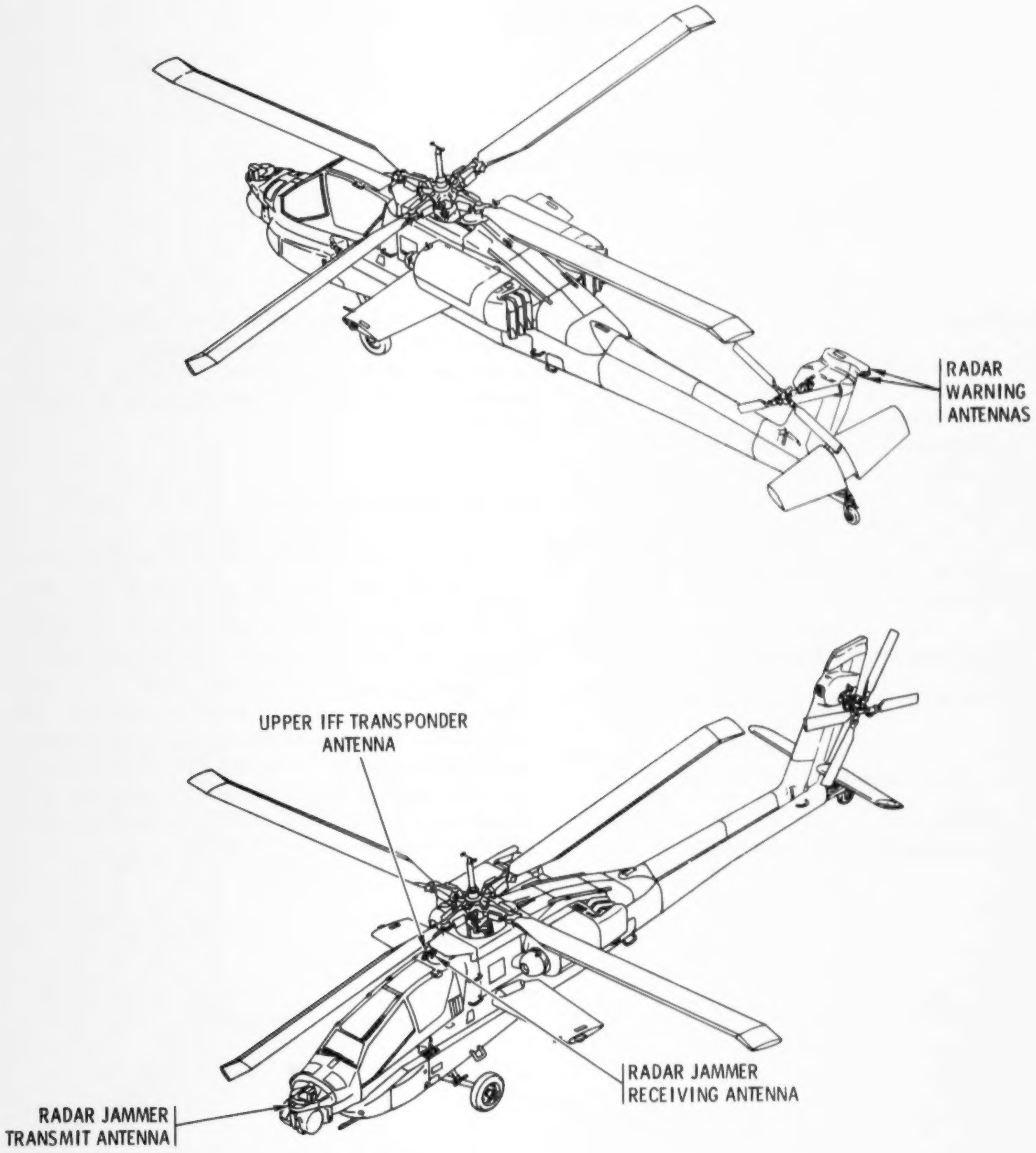

RADAR
WARNING
ANTENNAS
UPPER IFF TRANSPONDER
ANTENNA
RADAR JAMMER
RECEIVING ANTENNA
RADAR JAMMER
TRANSMIT ANTENNA
MM01-026D

Figure 3-1. Antenna Arrangement (Sheet 1 of 2)

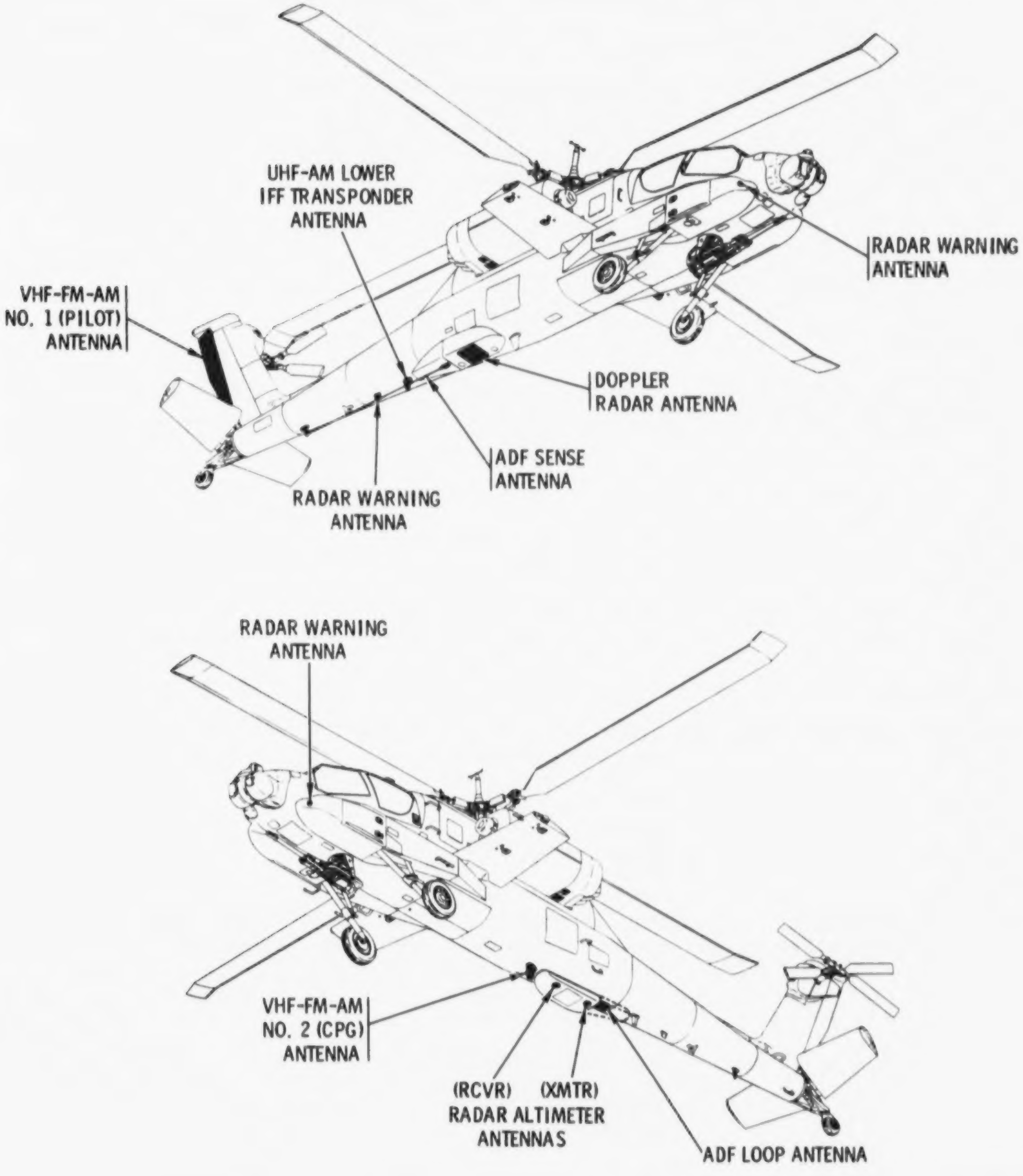

UHF-AM LOWER
IFF TRANSPONDER
ANTENNA
VHF-FM-AM
NO. 1 (PILOT)
ANTENNA
RADAR WARNING
ANTENNA
DOPPLER
RADAR ANTENNA
ADF SENSE
ANTENNA
RADAR WARNING
ANTENNA
RADAR WARNING
ANTENNA
VHF-FM-AM
NO. 2 (CPG)
ANTENNA
(RCVR) (XMTR)
RADAR ALTIMETER
ANTENNAS
ADF LOOP ANTENNA
MM01-027C

Figure 3-1. Antenna Arrangement (Sheet 2 of 2)

Table 3-1. Communication/Navigation Equipment

Provision	Nomenclature	Use	Range	Control Location	Remarks
Intercommunication	Intercommunication Control C-10414/ARC	Intercommunication between crew members and control of navigation and communication radios.	Within crew stations and two external receptacles.	Pilot center console and CPG right console.	
FM-AM Communication	Radio set AN/ARC-186 (V) VHF FM-AM No. 1.	Two-way FM voice communications. FM frequency range 30 to 87.975 MHz plus AM 118 to 152 MHz.	Line of sight	Pilot right console.	
FM-AM Communication	Radio set AN/ARC-186 (V) FM-AM No. 2.	Same as No. 1 VHF FM set.	Line of sight	CPG right console.	
UHF Communication	Radio set AN/ARC-164.	Two-way communication in the frequency range of 225 to 399.95 MHz.	Line of sight	Pilot right console .	Complete provisions
Voice Security System	TSEC/KY58 2/AHQ	Secure communication for pilot and CPG FM-AM radios.	Not applicable	Pilot right console and CPG right console.	
Automatic Direction Finder (ADF)	Direction finder set	Radio range and broadcast reception. Automatic direction finding and homing in the frequency range of 100 to 300 KHz.	50 NM	Pilot right console.	
Lightweight Doppler Navigation Set (LDNS)	Doppler Navigation set AN/ASN-128.	Provides present position or destination navigation information in latitude and longitude (degrees and minutes) or Universal Transverse Mercator (UTM) coordinates.	Not applicable	CPG right console	
Lightweight Doppler Navigation Set (LDNS)	Doppler Navigation set AN/ASN-137.	Provides present position or destination navigation information in latitude and longitude (degrees and minutes) or Universal Transverse Mercator (UTM) coordinates.	Not applicable	Not applicable	

Table 3-1. Communication/Navigation Equipment (cont)

Provision	Nomenclature	Use	Range	Control Location	Remarks
Computer Display Unit	IP-1552/G used with AN/ASN-137.	Provides controls and displays for operation of LDNS.	Not applicable	CPG right console	
Identification Friend or Foe	Transponder Set AN/APX 100 (V).	Transmits a specially coded reply to a ground based IFF radar interrogator system.	Line of sight	Pilot right console.	
Absolute Altimeter	Radar Altimeter AN/APN-209.	Measures absolute altitude.	0 to 1500 feet AGL.	Pilot right instrument panel	
Heading and Attitude Reference Set		Senses helicopter attitude and motion to define roll, pitch, heading, and flight path.	Not applicable	Pilot right instrument panel	

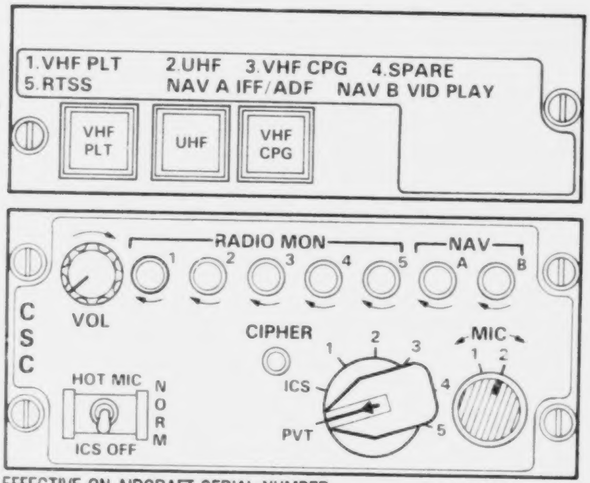
SECTION II. COMMUNICATIONS

3-5. INTERCOMMUNICATION SYSTEM C-10414(V)3/ARC - C-11746(V)4/ARC.

NOTE

The C-10414(V)3/ARC control panel is not illuminated.

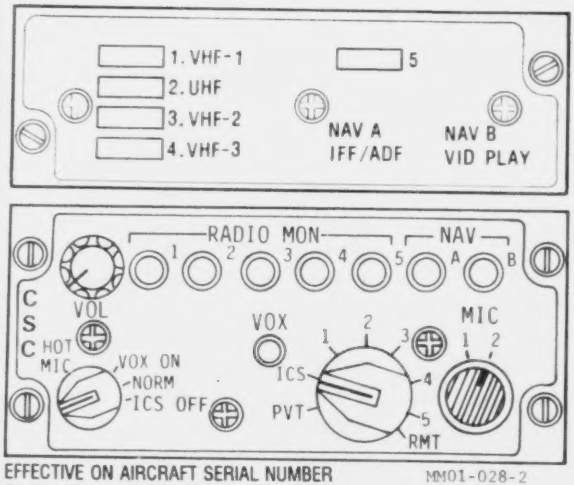
Two intercommunication systems (ICS) control panels (figure 3-2), one each for pilot and CPG, provide intercommunication capability between crew members. These also provide a means by which the pilot and CPG may select and control associated radio equipment for voice transmission and reception. Additionally, an external jack fitting on each service panel, located outboard on each wing pylon, permits maintenance personnel to communicate with the crew members. A radio transmit/interphone rocker switch is installed on both cyclic stick grips (figure 2-22). A foot-operated radio transmit switch is installed on the right side of the aft cockpit deck. The forward crew station has two foot-operated switches: a radio transmit switch on the left side of the deck, and an interphone transmit switch on the right side. Hands-free intercommunication is provided by a hot mike feature. The remote transmitter socket or switch pushbutton on the pilot cyclic stick grip, directly below the RADIO/ICS rocker switch, allows the pilot to remotely select the radio transmitter that he wishes to use. With the transmitter selector switch in position 5 (C-10414(V)3/ARC configuration) or position RMT (C-11746(V)4/ARC configuration), pressing this remote transmit select switch begins the transmitter select cycle. Identification of the selected transmitter is dis-played by way of lamps above the pilot COMM CONT panel. A placard is provided for each crew member as ready reference to which receiver and transmitter selector switch position will enable a desired radio. Power for the inter-communication system is provided from the emergency dc bus through a circuit breaker marked ICS in each crew station.


1.VHF PLT
2.UHF
3.VHF CPG
4.SPARE
5.RTSS
NAV A IFF/ADF
NAV B VID PLAY
VHF PLT
UHF
VHF CPG
RADIO MON
NAV
1
2
3
4
5
A
B
CSC
VOL
CIPHER
MIC
1
2
HOT MIC
NORM
ICS OFF
ICS
PVT
1
2
3
4
5

EFFECTIVE ON AIRCRAFT SERIAL NUMBER 83-23787 THRU 85-25415

MM01-028-1B

Figure 3-2. Communication Control Panel C-10414(V)3/ARC


1. VHF-1
2. UHF
3. VHF-2
4. VHF-3
5
NAV A IFF/ADF
NAV B VID PLAY
RADIO MON
NAV
1
2
3
4
5
A
B
CSC
VOL
HOT MIC
VOX ON
NORM
ICS OFF
VOX
MIC
1
2
ICS
PVT
1
2
3
4
5
RMT

EFFECTIVE ON AIRCRAFT SERIAL NUMBER 85-25416 AND SUBSEQUENT

MM01-028-2

Figure 3-2A. Communication Control Panel C-11746(V)4/ARC

3-6. Controls and Functions.

The function of the controls on the face of each COMM CONT panel (figure 3-2) is as follows:

CONTROL / INDICATOR	FUNCTION
Receiver Selector Switches ON	
1	Connects pilot's ARC-186 receiver to the headphone.
2	Connects UHF receiver to the headphone.
3	Connects CPG's ARC-186 receiver to the headphone.
4	Spare
5	Spare
NAV A	Connects the ARN-89 ADF receiver and the APX-100 IFF portion of the transponder to the headphone.
NAV B	Connects the audio output of the video recorder subsystem to headphone (playback mode of the VRS ONLY).

NOTE

The receiver switches are connected (ON) when pushed in fully and disconnected (OFF) when pulled out.

CONTROL / INDICATOR	FUNCTION
Transmitter Selector Switch	
ICS	Enables ICS System when keyed.
1	Enables Pilot's ARC-186 transmission when keyed.
2	Enables UHF transmission when keyed.
3	Enables CPG's ARC-186 transmission when keyed.
4	Spare
5 (C-10414 (V)3/ARC)	Enables remote transmit select switch. (Pilot only)
RMT (C-11746 (V)4/ARC)	Configuration enables RTSS. (Pilot only)
HOT MIC	Interphone transmit on at all times.
VOX ON	Enables VOX.
NORM	Interphone transmit functions only when interphone transmit switch pressed.
ICS OFF	Disables interphone transmit.
VOL Control	Adjusts headset volume level.
MIC Switch	
1	Used when SPH4 of IHADSS helmet is equipped with dynamic microphone M-87/AIC.
2	Used when SPH4 of IHADSS helmet is equipped with linear microphone M-170/AIC; normal helmet configuration. Mandatory for TEMPEST secure operation.

NOTE

If the pilot communication control panel MIC switch is in the 2 position, headsets connected to the right wing station ICS connector must also have a linear microphone or compensating adapter. If the CPG communication control panel MIC switch is in the 2 position, headsets connected to the left wing station ICS connector must also be configured correctly.

3-7. Modes of Operation.

There are several methods of intercommunication operation. In all cases, no operator action is required to receive intercom signals other than adjusting the VOL control for a comfortable level at the headset.

a. **Intercommunication for Both Crew Members.** Transmitting and receiving is accomplished by both crew members in the following manner:

(1) Transmitter selector switch is set to ICS when the pilot is using the ICS floor switch. The transmitter selector switch may be set at any position when using either cyclic stick RADIO/ICS rocker switch, ICS position.

(2) The RADIO/ICS rocker switch on either cyclic stick grip should be pressed to ICS or the CPG foot-operated ICS switch should be depressed (ground crew must depress a push-to-talk button on their ICS cord) to talk on the ICS. Speak

into the microphone while pressing any of these switches. Release switch to listen.

b. **External Radio Communication.** Both crew members are able to communicate with external receiving station in the following manner:

(1) Transmitter selectors – Set to the desired position, for either crew station, 1 through 3 or 5 for the pilot if he wishes to use the remote transmit select switch.

(2) RADIO/ICS rocker switches – Press the RADIO or depress either radio transmit floor switch. Speak into microphone while pressing switch; release to listen.

c. **Receiver Selection.** Place receiver selector switch(es) to ON as desired and adjust volume to a comfortable listening level.

3-8. RADIO SET AN/ARC-186(V).

Radio Set AN/ARC-186(V) (figure 3-3) is a VHF FM-AM transceiver that provides in the clear and secure voice communication capability at frequencies in both VHF, AM, and FM bands. Over a frequency range of 108.00 MHz to 115.975 MHz, Radio Set AN/ARC-186(V) functions as a receiver for the reception of amplitude-modulated (AM) transmissions. At frequencies in the range of 116.000 MHz to 151.975 MHz, the set operates both as an AM receiver and AM transmitter. From 108.000 MHz to 151.975 MHz, a total of 1760 AM voice communication channels spaced at 25 kHz, are provided by the set. In a range of frequencies extended from 30.000 MHz to 87.975 MHz, Radio Set AN/ARC-186(V) functions both as an FM receiver and FM transmitter. Operating in this frequency range, Radio Set AN/ARC-186(V) provides 2320 FM voice communication channels. The channels are spaced at 25 kHz. Radio Set AN/ARC-186(V) also provides 20-channel presets which can be any combination of AM or FM frequencies. Automatic tuning to both AM and FM emergency frequencies (121.5 MHz and 40.5 MHz, respectively) is provided by setting only one control. Power output of the transmitter section of the transceiver is 10 watts.

3-9. Antennas

The FM-AM No. 1 (pilot) communication antenna (figure 3-1) is mounted on the vertical stabilizer as an integral part of the trailing edge assembly. The FM-AM No. 2 (CPG) communication blade antenna is mounted on the bottom center fuselage area directly forward of the doppler antenna fairing.

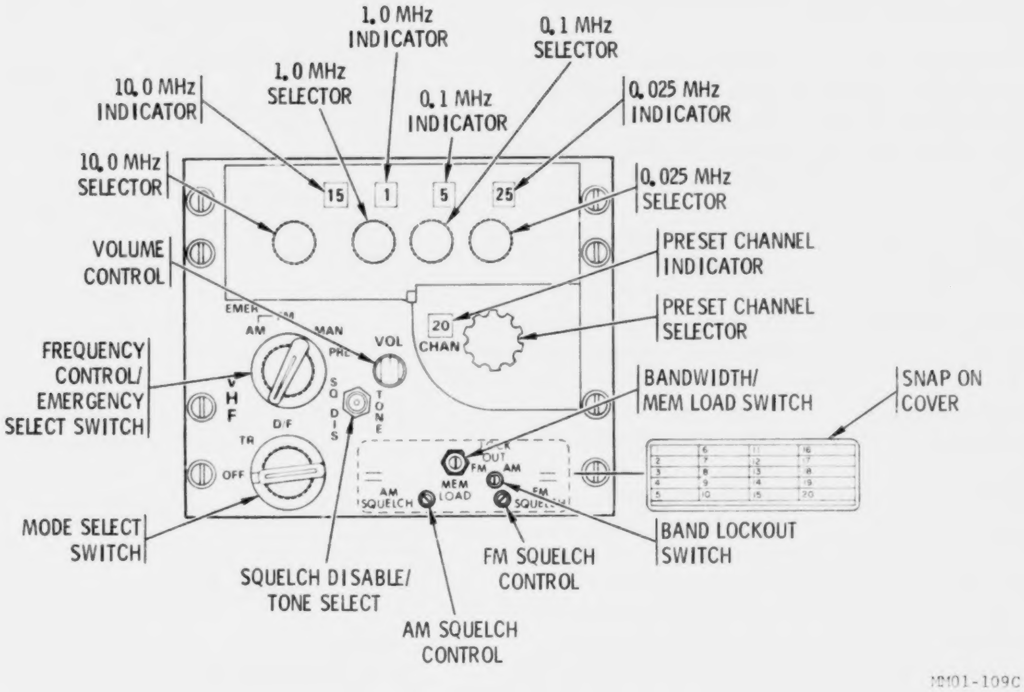

1.0 MHz INDICATOR
0.1 MHz SELECTOR
10.0 MHz INDICATOR
1.0 MHz SELECTOR
0.1 MHz INDICATOR
0.025 MHz INDICATOR
10.0 MHz SELECTOR
0.025 MHz SELECTOR
15
1
5
25
VOLUME CONTROL
PRESET CHANNEL INDICATOR
PRESET CHANNEL SELECTOR
EMER
FM
AM
MAN
PRE
VOL
20
CHAN
FREQUENCY CONTROL/ EMERGENCY SELECT SWITCH
VHF
SQ DIS
TONE
D/F
TR
OFF
BANDWIDTH/ MEM LOAD SWITCH
SNAP ON COVER
LOCK OUT
FM
AM
MEM LOAD
AM SQUELCH
FM SQUELCH
MODE SELECT SWITCH
BAND LOCKOUT SWITCH
SQUELCH DISABLE/ TONE SELECT
FM SQUELCH CONTROL
AM SQUELCH CONTROL
MM01-109C

Figure 3-3. Control AN/ARC-186(V)

3-10. Controls and Functions.

Controls for the AN/ARC-186(V) transceiver are on the front panel of the unit (figure 3-3). The function of each control is as follows:

CONTROL / INDICATOR	FUNCTION
0.025 MHz selector	Rotary switch. Selects r/t frequency in 0.025 MHz increments. Clockwise rotation increases frequency.
0.025 MHz indicator	Indicates manually selected r/t frequency in 0.025 MHz increments.
0.1 MHz selector	Rotary switch. Selects r/t frequency in 0.1 MHz increments. Clockwise rotation increases frequency.
0.1 MHz indicator	Indicates manually-selected r/t frequency in 0.1 MHz increments
1.0 MHz selector	Rotary switch. Selects r/t frequency in 1.0 MHz increments. Clockwise rotation increases frequency.
1.0 MHz indicator	Indicates manually selected r/t frequency in 1.0 MHz increments.
10 MHz selector	Rotary switch. Selects r/t frequency in 10 MHz increments from 30 to 150 MHz. Clockwise rotation increases frequency.
10 MHz indicator	Indicates manually selected r/t frequency in 10 MHz increments from 30 to 150 MHz.

CONTROL/INDICATOR	FUNCTION
Present channel selector	Rotary switch. Selects preset channel from 1 to 20. Clockwise rotation increases channel number selected.
Preset channel indicator	Indicates selected preset channel.
Volume control	Potentiometer. Clockwise rotation increases volume.
Squelch disable/ tone select	Three-position switch. Center position enables squelch. SQ DIS position disables squelch. Momentary TONE position transmits tone of approximately 1000 Hz.
Frequency control/ emergency select switch	Four-position rotary switch. EMER AM–FM selects a prestored guard channel. MAN position enables manual frequency selection. PRE position enables preset channel selection.
Mode select switch	Three-position rotary switch. OFF position disables r/t. TR position enables transmit receive modes.
Bandwidth/memory load switch	Three-position switch. NB position enables narrowband selectivity. WB enables wideband selectivity in the FM band. Momentary MEM LOAD allows manually selected frequency to go into selected preset channel memory.
AM squelch control	Screwdriver adjustable potentiometer. Squelch overridden at maximum counterclockwise position. Clockwise rotation increases input signal required to open the squelch.
FM squelch control	Screwdriver adjustable potentiometer. Squelch overridden at maximum counterclockwise position. Clockwise rotation increases input signal required to open the squelch.
Band lockout switch	Will lock out the AM or FM frequency of the band selected. Presently set to the center (LOCKOUT) position to receive both AM and FM bands.

3-11. Modes of Operation.

Depending on the setting of the operating controls, the radio set can be used for these modes of operation:

a. Control (mode) Settings.

(1) TR mode: two-way in the clear and secure voice communication. Refer to paragraphs 3-18 through 3-20 for voice security system.

(2) Not functional this installation.

(3) EMER AM-FM mode: emergency two-way voice communication on selected guard channel.

b. Transmit / Receive (TR) Mode.

(1) Set OFF-TR-D/F mode select switch to TR.

(2) Set EMER AM / FM-MAN-PRE frequency selector switch to MAN for manual frequency selection or to PRE for preset channel selection.

(3) To manually select a frequency, rotate the four MHz selector switches until desired frequency is displayed at indicator windows.

NOTE

Rotating the MHz selector switches clockwise increases frequency. Frequencies can be manually selected in 0.025 MHz increments.

(4) To select a preset channel, rotate preset channel selector switch until the number of the desired channel is displayed in preset CHAN indicator window.

NOTE

Clockwise rotation of preset channel selector switch will increase the desired channel number (1 to 20). The radio set will automatically tune to the preset channel in both TR and DF modes.

c. **AM Emergency (EMER AM) mode.**

(1) Set OFF-TR-DF mode select switch to either TR or D/F.

(2) Set EMER AM/FM-MAN-PRE frequency control/emergency select switch to EMER AM.

NOTE

Selecting the EMER AM mode will automatically disable the secure speech function and enable in the clear voice communication.

d. **FM Emergency (EMER FM) mode.** The FM Emergency mode enables voice reception/transmission on a prestored guard frequency of 40.500 MHz.

(1) Set OFF-TR-D/F mode select switch to either TR or D/F.

(2) Set EMER AM/FM-MAN-PRE frequency control/emergency select switch to EMER FM.

NOTE

Selecting the EMER FM mode will automatically disable the secure speech function and enable in the clear voice communication.

3-12. Operating Procedures, Radio Set AN/ARC-186.

a. **Squelch Disable.** To disable squelch, set squelch disable tone select SQ DIS/TONE switch to SQ DIS. Squelch will remain disabled (open) until switch is returned to center position.

b. **Tone Transmission.** To transmit (FM or AM) tone frequency of approximately 1000 Hz, set squelch disable tone select SQ DIS/TONE switch to the momentary TONE position. Releasing the switch disables the tone frequency.

c. **Loading Preset Channels.**

(1) Set OFF-TR-D/F mode select switch to TR.

(2) Set EMER AM/FM-MAN-PRE frequency control emergency select switch to MAN.

(3) Rotate the four MHz selector switches until desired frequency is displayed in indicator windows.

(4) Rotate CHAN preset channel selector switch until the desired channel is displayed in the indicator window.

(5) Remove SNAP-ON-COVER.

(6) Momentarily hold WB-NB-MEM LOAD switch to MEM LOAD. Preset frequency is now loaded into memory.

d. **Wideband/Narrowband Selection.**

(1) Remove SNAP-ON-COVER.

(2) For wideband operation, set WB-NB-MEM LOAD switch to WB.

(3) For narrowband operation, set WB-NB-MEM LOAD switch to NB.

NOTE

This switch shall be placed in the WB position at any time the MEM LOAD function is not being accomplished. The NB position is not used in this installation.

e. **Band Lockout Selection.**

(1) Remove SNAP-ON-COVER.

(2) Ensure LOCKOUT-FM-AM switch is in LOCKOUT position (indicated by a white dot on the switch).

NOTE

With the LOCKOUT-AM-FM switch set to AM or FM, the frequency of the band selected will be locked out. This will cause an audible warning to occur whenever a frequency in a locked out band is selected. For this installation, operational AM and FM bands are required and the LOCKOUT-AM-FM switch must be set to the LOCKOUT position.

3-13. Receiver-Transmitter Radio, RT-1167/ARC-164(V).

Receiver-Transmitter Radio RT-1167/ARC-164(V) (figure 3-4) is an airborne, ultra-high frequency (UHF), amplitude-modulated (AM), radio transmitting-receiving (transceiver) set. It contains a multichannel, electronically-tunable transceiver and a fixed-tuned guard receiver. The transceiver operates on any one of 7,000 channels spaced in 0.025 MHz units in the 225.000 to 399.750 MHz UHF military band. The guard receiver is tunable in the 238.000 to 248.000 MHz frequency range with crystal replacement and realignment (usually 243.000 MHz). The radio set primarily is used for voice communication. An additional radio set capability, although not functional is ADF. Power to operate the ARC-164(V) radio is from the 28 vdc emergency bus through a circuit breaker marked UHF-AM on the pilot overhead circuit breaker panel.

3-13.1. Receiver-Transmitter Radio, RT-1167C/ARC-164(V).

Receiver-Transmitter Radio RT-1167C/ARC-164(V) has the same functions and capabilities as the RT-1167/ARC-164(V) plus a HAVE QUICK mode of operation. HAVE QUICK is an antijamming mode which uses a frequency hopping scheme to change channels many times per second. Because the HAVE QUICK mode depends on a precise time of day, both HAVE QUICK radios must have synchronized clocks.

A-3-2-T Knob (HAVE QUICK ONLY)

* A – Selects AJ mode.
* 3 – Allows manual selection of frequencies.
* 2 – Allows manual selection of frequencies.
* T – Momentary position which enables the radio to accept a new TOD for up to 60 seconds after selection. Also used in conjunction with the emergency startup of the TOD clock when TOD is not available from a external source.

TONE Button (Have Quick) – Depressing the TONE button in normal or AJ modes interrupts reception and transmits a tone signal and TOD on the selected frequency. Simultaneously pressing the TONE button in conjunction with the A-3-2-T knob in the T position starts the emergency startup of the TOD clock.

HAVE QUICK System – The HAVE QUICK (HQ) system provides a jam resistant capability through a frequency hopping technique. Frequency hopping is a technique in which the frequency being used for a given channel is automatically changed at some rate common to the transmitter and receiver. The jam resistance of the system is due to the automatic frequency changing and the pseudorandom pattern of frequencies used. In order to defeat this communications system, the jammer must find the frequency being used, jam it and then

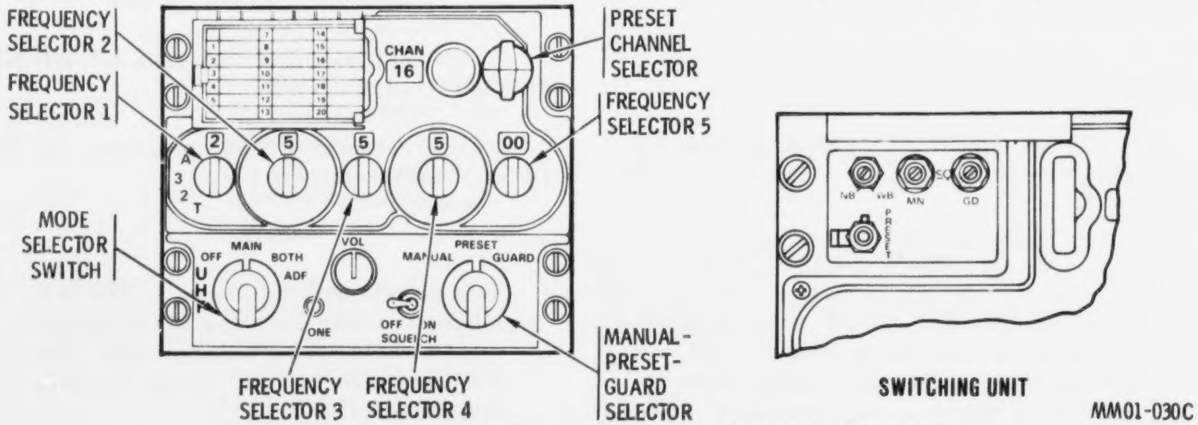


Figure 3-4. Receiver-Transmitter Radio, RT-1167/ARC-164(V)

predict or find the next frequency. The HAVE QUICK modification adds the frequency hopping capability, yet it does not remove any of the previous capabilities of the radio. The HAVE QUICK modified radios retain the standard, single frequency UHF voice mode of operations. This is referred to as the normal mode, while frequency hopping operation is called the anti-jam (AJ) mode. Several ingredients are necessary for successful system operations. These are:

1. Common frequency.
2. Time synchronization.
3. Common hopping pattern and rate.
4. Common net number.

The common frequencies have been programmed into all HAVE QUICK radios. Time synchronization is provided via UHF radio and/or hardware by external time distribution system. A time-of-day (TOD) signal must be received from the time distribution system for each time the radio is turned on. The hopping pattern and hopping rate are determined by the operator inserted word-of-day (WOD). The WOD is a multi-digit code, common worldwide to all HAVE QUICK users. In the AJ mode, a communications channel is defined by a net number instead of a signal frequency as in the normal mode. Before operating in the AJ mode, the radio must be primed. This consists of setting the WOD, TOD, and net number. The AJ mode is then selected by placing the A-3-2-T knob to A.

WORD OF DAY (WOD) – The WOD entry is normally entered before flight, but it is possible to enter it in flight. WOD is entered by using one or more of the six preset channels which are 20-15. For a new WOD entry, start at channel 20 and use the same method as in entering preset frequencies in the normal mode with the frequency knobs and the PRESET button. After each entry, a single beep is heard until channel 15 entry; a double beep is heard indicating that the radio has accepted all six WOD entries.

WOD TRANSFER – Select the preset mode and, starting with preset channel 20, rotate the preset knob CCW. At channel 20, a single beep is heard. A single beep indicates that channel 20 data has been transferred and accepted. After the single beep is heard, select remaining channels (19-15) in the same manner until a double beep is heard indicating the WOD transfer is complete.

TIME-OF-DAY (TOD) Transmission – The TOD entry is normally entered before flight, but it is possible to enter it in flight. It is possible to transmit timing information in both normal and AJ modes by momentarily pressing the TONE button. In the normal mode, a complete TOD message is transmitted, while in the AJ mode, only an abbreviated time update is transmitted. A mode time transmission allows a time update if one radio has drifted out of synchronization.

TIME-OF-DAY Reception – Reception is possible in both normal and AJ modes. The radio automatically accepts the first TOD message after the radio is turned on and WOD transferred. Subsequent messages are ignored unless the T position is selected with the A-3-2-T knob. The radio then accepts the next TOD update in either normal or AJ mode, provided the TOD update arrives within 60 seconds of the time the T position has been selected. To receive time in the normal mode, rotate the A-3-2-T knob to the T position and return to a normal channel in either the manual or preset mode. To receive a time update in AJ mode, rotate the A-3-2-T knob to the T position and then back to the A position. A TOD update (time tick) can be received on the selected AJ net.

Net Numbers – After WOD and TOD are entered, any valid AJ net number can be selected by using the manual frequency knob.

Anti-Jamming Mode Operation – A tone is heard in the headset if an invalid AJ net is selected, if TOD was not initially received, or if WOD was not entered. If the function knob is set to both and the AJ mode is selected, any transmission on the guard channel takes precedence over the AJ mode.

Operational Procedures – Radio Set AN/ARC-164(V)

1. Transfer WOD IAW "WOD TRANSFER" paragraph.
2. Set up RT to receive TOD:
   a. With external TOD equipment:
      (1) Select manual mode on MODE switch.
      (2) Set TOD frequency in manual frequency windows.
      (3) Set A-3-2-T to A, after TOD beep is heard. If tone is heard with the A-3-2-T in the A position, reinitialize radio IAW steps in "TOD TRANSMISSION" paragraph.

b. Without external TOD equipment: Emergency start-up of TOD clock:
  (1) Set and hold A-3-2-T switch to T.
  (2) Press the TONE button.

NOTE

When using this method, the flight commander or lead aircraft should emergency-start his TOD clock. Lead aircraft would then transfer TOD to other aircraft in flight. Aircraft using this method will not be able to communicate with valid TOD signal in the AF mode. A valid TOD signal must be transferred to all aircraft that have invalid TOD time before effective AJ communications can be achieved.

HAVE QUICK Checklist ARC-164. Loading Word-of-Day (WOD).

1. "T, 2, 3, A" switch – Not in A position.
2. Functional selector switch – Both.
3. Manual, preset, guard switch –Preset.
4. Manual frequency display – Set WOD 15.
5. Preset channel select – Set to 15.
6. Preset button (under frequency cover) – Press.
7. Manual frequency display – Set WOD 16.
8. Preset channel select – Set to 16.
9. Preset button – Press.
10. Repeat steps 7 thru 9 to store WOD 17, 18, 19.
11. Manual frequency display – Set 300.050.
12. Preset channel select – Set to 20.
13. Preset button – Press.
14. Rotate preset select down 19, 18, 17, 16, 15, (hear 1 beep 20 - 16, 2 beeps on 15).

Receiving Time from Net Control Aircraft.

1. Manual, preset, guard switch – Manual.
2. Set to internal frequency to receive the time.
3. Hear net control aircraft state: "Standby for time."
4. Rotate "T, 2, 3, A" switch to "T" and return to established manual frequency, hear.
5. Hear net control aircraft state: "Go active 0 point one."
6. Set A00.100 in manual window and complete commo check; if loud tone is heard, repeat timing.

Sending Time (Net Control Aircraft)

1. Manual, preset, guard switch – Manual.
2. Set to internal frequency.
3. Rotate "T, 2, 3, A" switch to "T" and hold.
4. Press tone button and hold (hear no tone).
5. "T, 2, 3, A" to internal frequency (.25 second beep, then tone).
6. Call other aircraft to send time.
7. Press tone button to send time.

NOTE

Recall today's WOD by reselecting presets 20 down thru 15, and hear beeps.

3-14. Antenna.

The UHF-AM antenna (figure 3-1) is located on the bottom center fuselage area and is mounted directly aft of the doppler fairing.

3-15. Controls and Functions (RT-1167).

Controls for the ARC-164(V) are on the front panel of the unit (figure 3-4). The function of each control is as follows:

CONTROL	FUNCTION
Frequency selector switch 1	Selects 100's digit of frequency (either 2 or 3) in MHz.
Frequency selector switch 2	Selects 10's digit of frequency (0 through 9) in MHz.
Frequency selector switch 3	Selects units digit of frequency (0 through 9) in MHz.
Frequency selector switch 4	Selects tenths digit of frequency (0 through 9) in MHz.
Frequency selector switch 5	Selects hundredths and thousandths digits of frequency (00, 25, 50, or 75) in MHz.

CONTROL	FUNCTION
Preset channel selector switch	Selects one of 20 preset channels.
MANUAL-PRESET-GUARD selector	Selects method of frequency selection.
MANUAL	Any of 7,000 frequencies is manually selected using the five frequency selector switches.
PRESET	A frequency is selected using the preset channel selector switch for selecting any one of 20 preset channels as indicated on the CHAN indicator.
GUARD	The main receiver and transmitter are automatically tuned to the guard frequency. Blocks out any frequency set either manually or preset.
SQUELCH ON-OFF switch	Turns squelch of main receiver on or off.
VOL control	Adjusts volume.
TONE switch	Enables transmission and headset monitoring of a 1.020-Hz tone on selected frequency for maintenance check only.
Mode selector switch	Selects operating mode:
OFF	Turns power off.
MAIN	Enables the transceiver.
BOTH	Enables transceiver and guard receiver.
ADF	Not operational.

3-15.1. Controls and Functions (RT-1167C).

The controls and functions of the RT-1167C/ARC-164(V) are identical to the RT-1167/ARC-164(V) with the exception of the following:

CONTROL	FUNCTION
Frequency selector switch 1 (T-2-3-A)	Selects 100's digit of frequency (either 2 or 3) in MHz. The A position selects the HAVE QUICK mode. The T position (spring-loaded) allows the radio to receive a new time of day.

3-16. Modes of Operation.

Depending on the settings of the operating controls, the radio set can be used for these modes of operation:

a. Control (Mode) Settings.

(1) MAN mode: two-way voice communications.

(2) BOTH mode: utilizing the transceiver constant monitoring of guard receiver without losing the use of the transceiver.

(3) Transmission of 1,020 Hz TONE signal.

b. Transmit / Receive (MAIN) mode.

(1) Set OFF-MAIN-BOTH-ADF selector switch to MAIN.

(2) Set MANUAL-PRESET-GUARD selector switch to MANUAL for manual frequency selection or to PRESET for preset channel selection.

(3) To manually select a frequency, rotate the five MHz selector switches until desired frequency is displayed in indicator windows.

NOTE

Clockwise rotation of the MHz selector switches increases frequency.

(4) To select a preset channel, rotate preset channel selector switch until desired channel is displayed in preset CHAN indicator window.

NOTE

Clockwise rotation of preset channel selector switch will increase the desired channel number (1 to 20).

c. **Transmit / Receive / Guard Monitor (BOTH) Mode.**

(1) Set OFF-MAIN-BOTH-ADF selector switch to BOTH.

NOTE

The BOTH position turns on the transceiver and the guard receiver. The guard receiver will remain turned to 243 MHz regardless of manual or preset frequencies selected.

(2) Select desired manual frequency or preset channel (paragraph 3-16b (3) and (4)).

NOTE

If reception on the selected frequency interferes with guard reception, detune the set by selecting an open frequency or place MANUAL-PRESET-GUARD selector switch to GUARD.

d. **1020 Hz TONE Signal Transmission (MAIN) mode.**

(1) Set OFF-MAIN-BOTH-ADF selector switch to MAIN.

(2) Select a desired frequency for TONE transmission. Refer to steps 3-16b (3) and (4).

(3) Push the TONE switch to transmit the 1020 Hz signal.

NOTE

Tone-modulated signal may be used to check out the radio set and isolate faulty microphone circuitry.

e. **HAVE QUICK mode (RT-1167C only).**

The HAVE QUICK mode can be activated in one of two ways:

(1) Set MANUAL-PRESET-GUARD switch to MANUAL and set frequency selector switch 1 to A.

(2) Set MANUAL-PRESET-GUARD switch to PRESET and set preset channel selector switch to channel 20.

3-17. Operational Procedures Radio Set AN/ARC-164.

a. **Guard (Emergency) Operation.**

(1) Set MANUAL-PRESET-GUARD selector switch to GUARD.

NOTE

Transmission on guard frequency will also occur with transceiver manual frequency or preset channel tuned to the guard frequency.

b. **Loading Preset Channels.**

(1) Use the manual frequency selector switches to select the frequency to be placed into memory.

(2) Set MANUAL-PRESET-GUARD selector switch to PRESET.

(3) Turn preset channel selector switch to the desired channel number.

(4) Raise switching unit cover.

(5) Press and release PRESET switch. Preset frequency is now loaded into memory.

3-18. VOICE SECURITY SYSTEM TSEC / KY-58.

The TSEC KY-58 provides secure voice (ciphony) on the pilot's VHF FM radio. The pilot uses the KY-58 remote control unit (RCU) located in his right-hand console to operate the TSEC/KY-58, which in turn controls the AN/ARC-186(V) (FM No. 1) radio set (also located in the right-hand console). Power to operate the TSEC/KY-58 comes from the 28-vdc emergency bus through a circuit breaker labeled KY-58 on the pilot overhead circuit breaker panel. Two operating modes are available: PLAIN mode for in-the-clear voice transmission or reception, and C/RAD 1 (cipher) mode for secure radio transmission or reception.

NOTE

The TSEC/KY-58 POWER switch must be set to ON and the KY-58 circuit breaker must be closed before VHF No. 1 radio communication (plain or ciphered) is possible.

3-19. Controls and Functions.

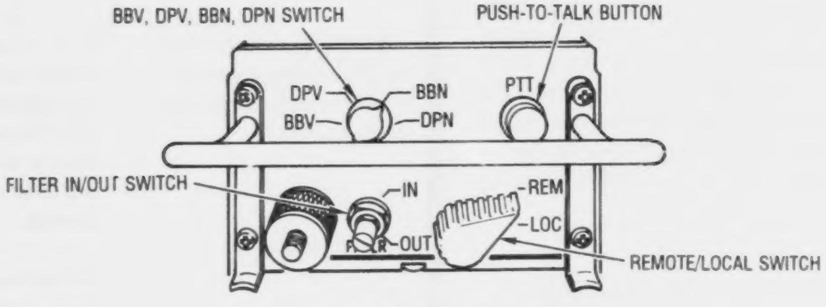
Voice security system controls that require adjustment by the pilot include those on Z-AHQ Power Interface Adapter (located in the aft avionics bay), the Z-AHP KY-58 Remote Control Unit (located in the pilot's right-hand console), and the TSEC/KY-58 (also located in the pilot's right-hand console). Each of these devices is shown in figure 3-5. The function of each control and indicator is as follows:

Z-AHQ POWER INTERFACE ADAPTER

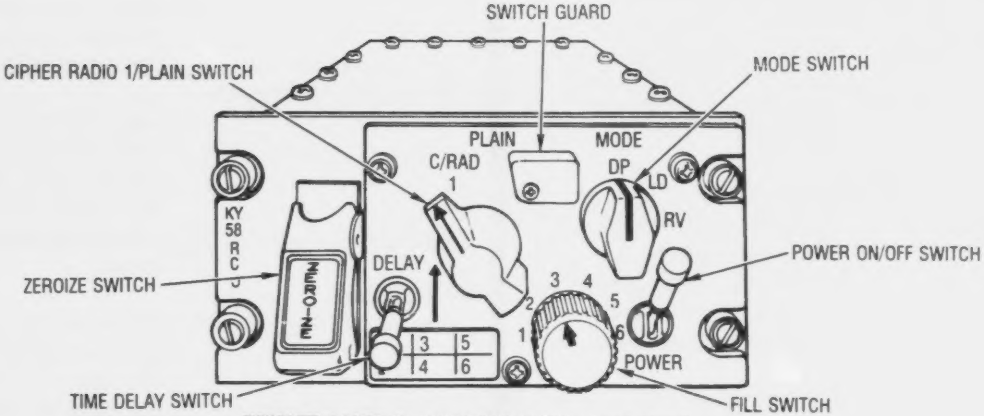
CONTROL OR INDICATOR	FUNCTION
BBV, DPV, BBN, DPN 4-position switch	Set according to type of radio being secured. Set to BBV for pilot's VHF FM radio.
PTT button (push-to-talk)	Clears crypto alarm that occurs upon power up. Alarm can also be cleared by pressing any push-to-talk switch in the pilot compartment.
FILTER IN/OUT Selector	Prevents adjacent channel interference when using radios with channel spacing of 25 kHz. Must be set to IN for pilot's AN/ARC-186(V) VHF-FM radio.
REM/LOC Switch	Sets the Z-AHQ to the local mode. Switch returns to REM (remote) position upon release, but equipment remains in local mode until any PTT is keyed.

Z-AHP REMOTE CONTROL UNIT

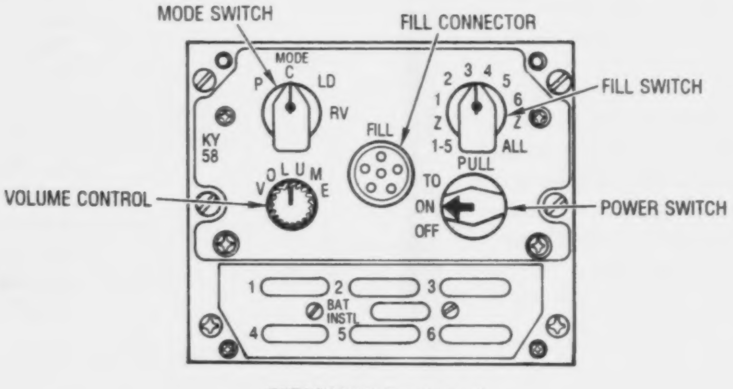
CONTROL OR INDICATOR	FUNCTION
ZEROIZE switch (two-position toggle switch housed under a spring-loaded cover)	Use in an emergency to delete all crypto-net variables (CNVs) from KY-58 registers. Renders KY-58 unusable until new variables are loaded.
DELAY Switch	Introduces time delay that is necessary when secure signal from pilot's VHF-FM radio is to be retransmitted by receiving station. Switch is normally in the down (off) position.
C/RAD 1/PLAIN switch	Set switch to C/RAD 1 (cipher radio 1) to use secure voice. Set switch to PLAIN when operating radio in the clear.
Switch guard	Rotate to the left to prevent C/RAD 1/PLAIN switch from accidentally being set to PLAIN.
MODE Switch	Set to OP (operate) to use pilot's VHF radio in either the Ciphered or Plain mode. Set to LD (load) when installing crypto-net variables (CNV) in the TSEC/KY-58 (TM 5810-262-12&P). Set to RV (receive variable) during manual remote keying (TM 5810-262-12&P).


BBV, DPV, BBN, DPN SWITCH
PUSH-TO-TALK BUTTON
DPV
BBN
BBV
DPN
PTT
FILTER IN/OUT SWITCH
IN
REM
LOC
OUT
REMOTE/LOCAL SWITCH

Z-AHQ POWER INTERFACE ADAPTER


SWITCH GUARD
CIPHER RADIO 1/PLAIN SWITCH
MODE SWITCH
PLAIN
MODE
C/RAD
1
DP
LD
RV
KY
58
R
C
U
POWER ON/OFF SWITCH
ZEROIZE SWITCH
ZEROIZE
DELAY
2
3
4
5
6
1
3 5
4 6
POWER
TIME DELAY SWITCH
FILL SWITCH

REMOTE CONTROL UNIT(RCU) Z-AHP, Front Panel


MODE SWITCH
FILL CONNECTOR
MODE
P
C
LD
RV
2 3 4 5
1
6
Z
Z
1-5
ALL
FILL SWITCH
FILL
KY
58
PULL
VOLUME
TO
ON
OFF
VOLUME CONTROL
POWER SWITCH
1
2
3
BAT
INSTL
4
5
6

TSEC/KY-58, Front Panel

MM01-220

Figure 3-5. Voice Security System Equipment

Z-AHP REMOTE CONTROL UNIT (cont)

CONTROL OR INDICATOR	FUNCTION
POWER	Turns KY-58 on and off. Switch must be on (up) for operation in either plain or cipher mode.
FILL switch	Selects desired crypto-net variable (CNV).

TSEC/KY-58

CONTROL OR INDICATOR	FUNCTION
VOLUME control	Sets audio level of pilot's VHF-FM radio.
MODE switch	Set to P (Plain) to operate pilot's VHF-FM radio in the clear. Set to C (Cipher) to operate pilot's VHF-FM radio in the ciphered (secure speech) mode. Set to LD (load) when installing crypto-net variables (CNV) in the TSEC/KY-58 (TM 5810-262-12&P). Set to RV (receive variable) during manual remote keying (TM 5810-262-12&P).
FILL connector	Used to load crypto-net variables (CNV's) into the TSEC/KY-58 registers (TM 5810-262-12&P).
FILL switch	Pull knob and set to Z1-5 to zeroize (delete) crypto-net variables (CNV's) in TSEC/KY-58 registers 1-5. Set to 1, 2, 3, 4 or 5 to select desired CNV. Pull knob and set to Z-ALL to zeroize (delete) crypto-net variables (CNV's) in all TSEC/KY-58 registers. Zeroizing all registers renders TSEC/KY-58 unusable.

TSEC/KY-58 (cont)

CONTROL OR INDICATOR	FUNCTION
Power switch	Set to OFF to turn off both the TSEC/KY-58 and the pilot's VHF-FM radio. Set to ON to operate the TSEC/KY-58 and pilot's VHF-FM radio. Set to TD (time delay) when secure voice from pilot's VHF-FM radio is to be retransmitted.

3-20. Operation.

a. Preliminary Operation.

NOTE

Before the pilot's VHF-FM radio may be operated in ciphered (secured voice) mode, it must be loaded with one or more crypto-net variables (CNV's). Refer to TM 11-5810-262-12&P for complete details on loading these variables.

(1) Set the TSEC/KY-58 Power switch to ON.

(2) Set the TSEC/KY-58 MODE switch to C (cipher).

(3) Set the TSEC/KY-58 VOLUME control to a comfortable listening level.

(4) Set the TSEC/KY-58 FILL switch to any one of the numbered storage register positions (1-6).

(5) Set the Z-AHQ Power Interface Adapter 4-position switch to BBV.

(6) Set the Z-AHQ Power Interface Adapter FILTER selector to IN.

(7) Place the DELAY switch on the Z-AHP Remote Control Unit (RCU) in the down (off) position.

(8) Set the C/RAD 1-PLAIN switch on the Z-AHP Remote Control Unit (RCU) to the C/RAD 1 position.

(9) Set the MODE switch on the Z-AHP Remote Control Unit (RCU) to the OP position.

(10) Set the FILL switch on the Z-AHP Remote Control Unit (RCU) to the proper crypto-net variable (CNV).

(11) Set the POWER switch on the Z-AHP Remote Control Unit (RCU) to the ON position.

NOTE

At this time you should hear an intermittent tone and background noise. The background noise is normal. The tone is a crypto alarm that must be cleared before the radio can be used. If step 12 does not clear the intermittent tone, double check steps 1 through 11. If necessary, refer to pages 32-37 of TM 11-5810-262-OP.

(12) Press and release the ICS switch on the pilot cyclic stick or the pilot's push-to-talk floor switch. This should clear the crypto alarm.

b. Cipher Mode

(1) After steps 1 through 12 (above) are complete, the radio is ready to transmit and receive secure speech in ciphered mode.

(2) To transmit, press any push-to-talk switch. You may begin speaking following the beep.

c. Plain Mode

(1) To transmit and receive in the clear, set the C/RAD 1/PLAIN switch on the Z-AHP Remote Control Unit to PLAIN.

(2) To transmit, press any push-to-talk switch. You may begin speaking immediately.

d. Automatic Remote Keying (AK)

NOTE

Automatic Remote Keying (AK) causes an old crypto-net variable in one of the TSEC/KY-58 registers to be replaced by a new one, or an empty register to be filled. Your net controller simply transmits the new CNV to your TSEC/KY-58.

(1) Your net controller will contact you by using a secure voice channel, and tell you to wait for an AK transmission. You must not transmit during this period.

(2) You will hear one or two beeps in your headset when the AK occurs.

c. Manual Remote Keying (MK)

NOTE

Manual Remote Keying (MK) requires you to use the Z-AHP Remote Control Unit to change crypto-net variables (CNV's).

(1) The net controller will contact you by using a secure voice channel. He will tell you to stand by for a new or replacment CNV and that you will use an MK action.

(2) Set the Z-AHP RCU FILL switch to position 6. Notify the net controller by radio when you have done this and stand by.

(3) The net controller will tell you to set the Z-AHP RCU MODE switch to RV (receive variable). Notify the net controller when you have done this and stand by.

(4) When notified by the net controller, set the Z-AHP RCU FILL switch to the storage position selected to receive the CNV. Notify the net controller when you have done this, and stand by.

(5) The net controller will ask you to listen for a beep, wait two seconds, and set the Z-AHP RCU MODE switch to OP (operate).

(6) If the MK operation was successful, the net controller will contact you via the new CNV. If the MK operation was not successful, the net controller will contact you by a clear voice (plain) transmission, tell you to set your RCU FILL switch to position 6, and stand by while the MK operation is repeated.

3-21. Voice Security System TSEC / KY-28.

Not installed.

SECTION III. NAVIGATION

3-22. DIRECTION FINDER SET AN/ARN-89.

Direction finder set AN/ARN-89 (figure 3-6) is an airborne, low frequency (LF), automatic direction finder (ADF) radio that provides an automatic or manual compass bearing on any radio signal within the frequency range of 100 to 3,000 kHz. The ADF displays helicopter bearing relative to a selected radio transmission. On the pilot instrument panel, it is shown by the bearing pointer of the horizontal situation indicator No. 2 (figure 2-9). On the CPG panel, it is shown on the bearing pointer within the radio magnetic indicator (RMI) (figure 2-10). The ADF has three modes of operation that permit it to function as a continuous wave automatic direction finder, a continuous wave manual direction finder, or as an amplitude-modulated (AM) broadcast receiver. Power to operate the set is provided by the 28 vdc emergency bus through a circuit breaker marked ADF on the pilot overhead circuit breaker panel.

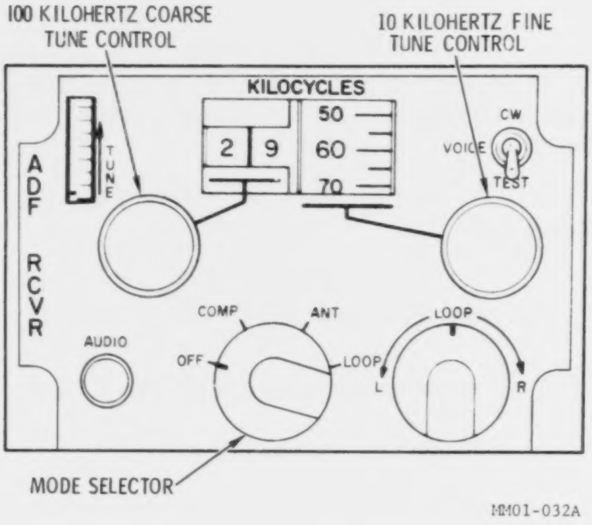


Figure 3-6. C-7932/ARN-89 Control Panel

3-23. Antennas.

The ADF antennas (figure 3-1) are located on the bottom center fuselage area, aft of the doppler/radar altimeter antenna fairing. The ADF loop antenna is mounted under the aft fairing. The ADF sense wire antenna is supported between the aft fairing and a 7-inch standoff 12 feet aft of the fairing.

3-24. Controls and Functions.

Controls for the AN/ARN-89 are on the front panel of the C-7932 installed on the pilot right console (figure 3-6). The function of each control is as follows:

CONTROL	FUNCTION
Mode selector switch	
OFF	Turns power to the set OFF.
COMP	Provides for operation as an ADF.
ANT	Provides for operation as an AM receiver using the sense antenna.
LOOP	Provides for receiver operation as a manual direction finder using only the loop antenna.
LOOP L-R control knob	Manually provides for left and right control of the loop when the mode selector switch is in loop position. This control knob is spring-loaded to return to center.
AUDIO	Adjusts audio volume for station indentification.

CONTROL	FUNCTION
KILOCYCLES indicator	
100 KHz coarse-tune control knob	Tunes receiver in 100 KHz steps as indicated by first two digits of the KILOCYCLES indicator.
10 KHz fine tune control knob	Tunes receiver in 10 KHz steps as indicated by last two digits of KILOCYCLES indicator.
CW, VOICE, TEST switch	
CW (in the COMP mode)	Enables the tone oscillator to provide an audible tone for tuning to a continuous wave (CW) station when the mode selector switch is at COMP.
CW (ANT or LOOP mode)	Enables the beat frequency oscillator to permit tuning to a CW station when the mode selector switch is at ANT or LOOP.
VOICE	Permits low frequency receiver to operate as a receiver when the mode selector switch is at any position.
TEST (in the COMP mode)	Provides for slewing of the loop through 180 degrees to check operation of the receiver in the COMP mode. This switch position is inoperative in LOOP and ANT modes.
TUNE meter	Indicates relative signal strength while tuning the set to a specific radio signal.
KILOCYCLES indicator	Indicates operating frequency to which receiver is tuned.

3-25. Operation.

a. Starting Procedure.

(1) Mode selector switch – COMP, ANT, or LOOP.

(2) Frequency – Select.

(3) CW, VOICE , TEST switch – CW or VOICE as desired.

(4) Communications control panel NAV receiver select switch – ON.

(5) Fine tune control – Adjust for maximum upward indication on the TUNE meter.

(6) AUDIO control -- Adjust as desired.

b. COMP Mode Operation.

(1) Mode selector switch – COMP.

(2) The horizontal situation indicator No. 2 bearing pointer and the radio magnetic indicator bearing pointer will display the magnetic bearing to the ground station.

(3) Test the ADF as follows:

(a) CW, VOICE, TEST switch – Set to TEST position. Check that both bearing pointers associated with the ADF rotate approximately 180 degrees.

(b) CW, VOICE, TEST switch – Release.

c. ANT Mode Operation.

(1) Mode selector switch – ANT.

(2) Monitor receiver in headset.

d. LOOP Mode Operation (manual direction finding).

(1) Set OFF-COMP-ANT-LOOP selector switch to LOOP.

(2) Turn the LOOP L-R knob to L (left) or R (right) to obtain an audio null and a TUNE indicator null. Check either ADF bearing pointer for a display of magnetic bearing to or from the station. The two null positions may be as much as 180 degrees apart in this mode.

3-26. Doppler Navigation Sets.

The AH-64A helicopter is equipped with one of two doppler navigation sets (DNS): AN/ASN-128 or AN/ASN-137 DNS. Which DNS is installed may be determined by what Computer Display Unit (CDU) is installed in the CPG right-hand console. The CDU shown in figure 3-7 identifies that helicopter as equipped with the AN/ASN-128 DNS. Aircraft with the CDU shown in figure 3-7.1 are equipped with the AN/ASN-137 DNS.

The navigation accuracy of both DNS are the same. The DNS, in conjunction with the heading attitude reference set (HARS), provides the helicopter velocity, position, and steering information. DNS accuracy may degrade at altitudes above 10,000 feet agl, and at pitch and roll angles greater than 30 and 45 degrees, respectively. The DNS is a self-contained navigation system capable of providing world-wide position readouts in either Universal Transverse Mercator (UTM) or WGS-84 Latitude and Longitude (LAT/LONG) coordinates. Navigation calculations are accomplished by the DNS in LAT/LONG and then converted to UTM (if necessary) for display purposes. Coordinate data may be entered in either coordinate format. The AN/ASN-128 DNS has 10 internal storage locations for coordinate data. The AN/ASN-137 DNS in conjunction with the IP-1552G CDU has the capability for 20 storage locations.

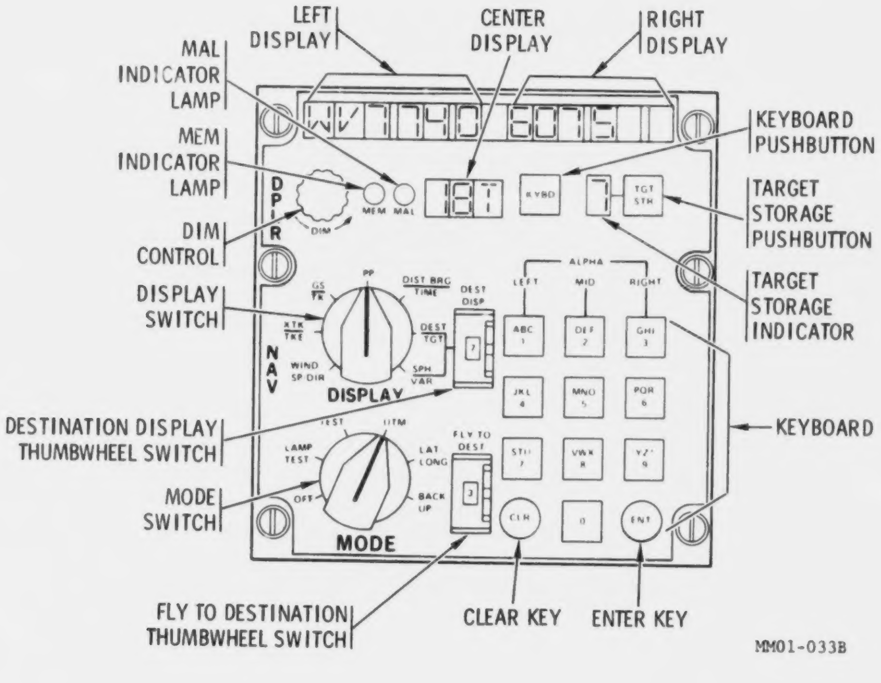

LEFT DISPLAY
CENTER DISPLAY
RIGHT DISPLAY
MAL INDICATOR LAMP
MEM INDICATOR LAMP
DIM CONTROL
DISPLAY SWITCH
DESTINATION DISPLAY THUMBWHEEL SWITCH
MODE SWITCH
FLY TO DESTINATION THUMBWHEEL SWITCH
KEYBOARD PUSHBUTTON
TARGET STORAGE PUSHBUTTON
TARGET STORAGE INDICATOR
KEYBOARD
CLEAR KEY
ENTER KEY
WV 7740 6075
DPIR
MEM
MAL
DIM
KYBD
TGT STR
ALPHA
LEFT
MID
RIGHT
ABC 1
DEF 2
GHI 3
JKL 4
MNO 5
PQR 6
STU 7
VWX 8
YZ* 9
CLR
0
ENT
NAV
GS/TK
PP
DIST BRG/TIME
DEST DISP
XTK/TKE
DEST/TGT
WIND SP DIR
SPH/VAR
DISPLAY
TEST
UTM
LAMP TEST
LAT LONG
FLY TO DEST
OFF
BACK UP
MODE
MM01-033B

Figure 3-7. Computer Display Unit CP-1252 AN/ASN-128

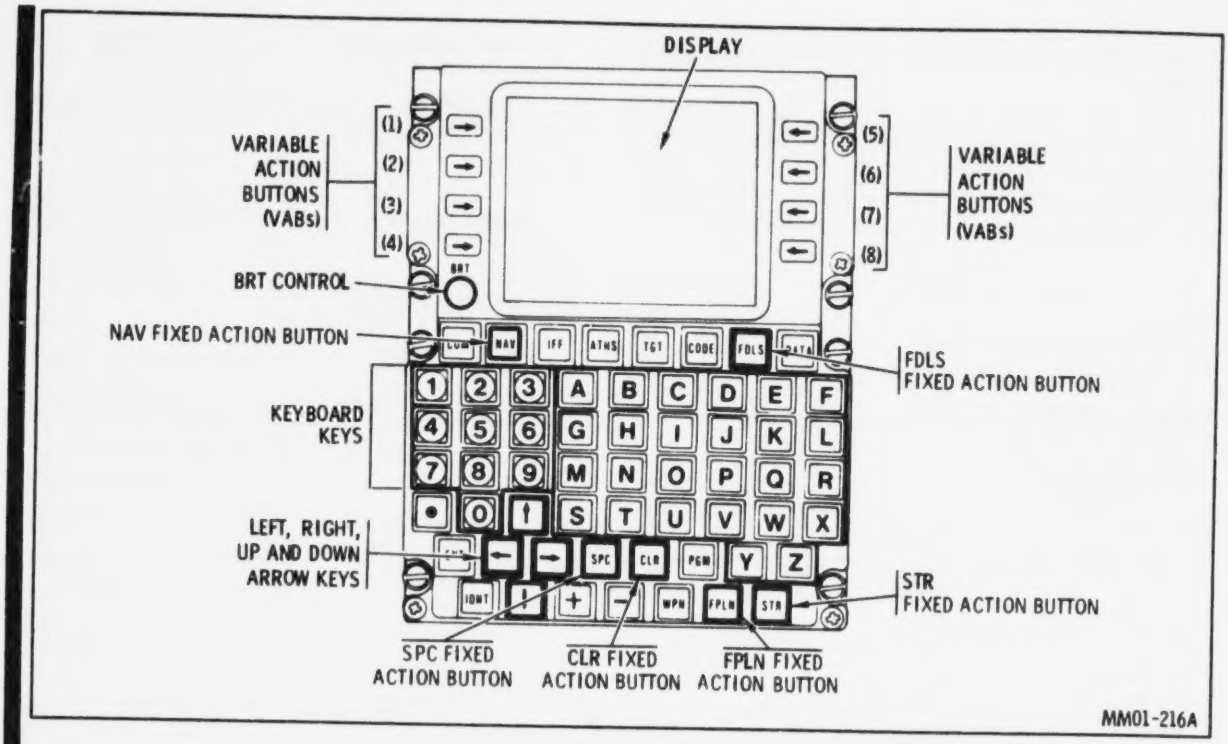

DISPLAY
VARIABLE ACTION BUTTONS (VABs)
(1)
(2)
(3)
(4)
(5)
(6)
(7)
(8)
VARIABLE ACTION BUTTONS (VABs)
BRT CONTROL
NAV FIXED ACTION BUTTON
FDLS FIXED ACTION BUTTON
KEYBOARD KEYS
LEFT, RIGHT, UP AND DOWN ARROW KEYS
STR FIXED ACTION BUTTON
SPC FIXED ACTION BUTTON
CLR FIXED ACTION BUTTON
FPLN FIXED ACTION BUTTON
MM01-216A

Figure 3-7.1. Computer Display Unit IP-1552/G Used with AN/ASN-137

Power to operate the AN/ASN-128 DNS is provided through the DPLR circuit breaker on the pilot overhead circuit breaker panel. In addition to the DPLR circuit breaker, the AN/ASN-137 DNS also uses power provided through the MUX FAB R circuit breaker on the CPG circuit breaker panel No. 1 and through the CDU circuit breaker on the CPG circuit breaker panel No. 2.

3-27. DNS Antenna.

The DNS antenna for both systems is identical. The antenna is a combined antenna/radome and receiver/transmitter housing located in the fairing on the bottom center fuselage area as shown in figure 3-1.

3-28. AN/ASN-128 Controls, Displays, and Function.

The controls and displays for the LDNS are on the front of the computer display unit (CP-1252/G AN/ASN-128) located on the CPG right console (figure 3-7). The function of each control is as follows:

NOTE

All references to headings or track angle degrees are referred to magnetic north.

3-28. AN/ASN-128 Controls, Displays, and Function.

The controls and displays for the LDNS are on the front of the computer display unit (CP-1252/ASN-128) located on the CPG right console (figure 3-7). The function of each control is as follows:

NOTE

All references to headings or track angle degrees are referred to magnetic north.

CONTROL / INDICATOR	FUNCTION
MODE Selector	
OFF	Turns off electrical power to the set.
LAMP TEST	Checks the operation of all lamps.
TEST	Initiates a built-in-test (BIT) exercise for the LDNS.
UTM	Selects Universal Transverse Mercator (UTM) as the navigational mode of operation.
LAT/LONG	Selects latitude/longitude as the navigational mode of operation.
BACKUP	Places navigation set in true airspeed plus remembered wind mode of operation. If true airspeed is not available, places navigation set in remembered velocity mode of operation.
DISPLAY selector	Selects navigation data for display.
WIND SP/DIR (Left Display)	Windspeed in kilometers per hour (km/h).
(Right Display)	Wind direction relative to true north (degrees).
XTK-TKE (Left Display)	Distance crosstrack (XTK) of initial course to destination in km and tenths of a km.
(Right Display)	Track angle error (TKE) in degrees displayed as right or left of bearing to destination.
GS-TK (Left Display)	Ground speed (GS) in km/hr.
(Right Display)	Track angle (TK) in degrees.
PP (MODE switch set to UTM) (Center Display)	Present position UTM zone.
(Left Display)	Present position UTM area square designator and easting in km to nearest ten meters.
(Right Display)	Present position UTM area northing in km to nearest ten meters.
PP (MODE switch set to LAT/LONG) (Left Display)	Present position latitude in degrees, minutes, and tenths of minutes.
(Right Display)	Present position longitude in degrees, minutes, and tenths of minutes.
DIST/BRG-TIME (Center Display)	Time to destination selected by FLY TO DEST (in minutes and tenths of minutes).
(Left Display)	Distance to destination selected by FLY TO DEST (in km and tenths of a km)
(Right Display)	Bearing to a destination selected by FLY TO DEST (in degrees).
DEST – TGT (Mode switch set to UTM) (Center Display)	UTM zone of destination selected by DEST DISP thumbwheel.
(Left Display)	UTM area and easting of destination set on DEST DISP thumbwheel.

CONTROL / INDICATOR	FUNCTION
(Right Display)	Northing of destination set on DEST DISP thumbwheel.
DEST-TGT (Mode switch set to LAT/LONG) (Left Display)	Latitude (N 84° or S 80° max.) of destination set on DEST DISP thumbwheel.
(Right Display)	Longitude of destination set on DEST DISP thumbwheel.
SPH-VAR (Left Display)	Spheroid code of destination set on DEST DISP thumbwheel.
(Right Display)	Magnetic variation (in degrees and tenths of degrees) of destination set on DEST DISP thumbwheel.
MEM Indicator Lamp	Lights when radar portion of navigation set is in non-track condition.
MAL Indicator Lamp	Lights when navigation set malfunction is detected by built in self-test.
DIM Control	Control light intensity of display characters.
Left, Right, and Center Display Lamps	Lights to provide data in alphanumeric and numeric characters, as determined by setting of DISPLAY switch, MODE switch, and operation of keyboard.
Target Storage Indicator	Displays destination number (memory location) in which present position will be stored when TGT STR pushbutton is pressed.
TGT STR Pushbutton	Stores present position data when pressed.

CONTROL / INDICATOR	FUNCTION
KYBD Pushbutton	Used in conjunction with the keyboard to allow data to be entered into the computer.
DEST DISP Thumbwheel Switch	Destination display thumbwheel switch is used along with DEST-TGT and SPH-VAR position of DISPLAY switch to select destination whose coordinates or magnetic variation are to be displayed or entered. Destinations are 0 through 9, P (Present Position) and H (Home).
Keyboard	Used to set up data for entry into memory. When the DISPLAY switch is tuned to the position in which new data is required and the KYBD pushbutton is pressed, data may be displayed on the appropriate left, right, and center display. To display a number, press the corresponding key or keys (1 through 0). To display a letter, first depress the key corres-ponding to the desired letter. Then depress a key in the left, middle, or right column, corresponding to the position of the letter on the key. Example: to enter an L, first depress L, then 3, 6, or 9 in the right column.
FLY-TO DEST Thumbwheel Switch	Selects the destination for which XTK/TKE and DIST/BRG/TIME are displayed when the DIS-PLAY switch is turned to either of these positions fromwhich steering information is desired. Destinations are 0 through 9, and H (Home).

CONTROL/INDICATOR	FUNCTION
ENT key	Enters data set up on keyboard into memory when pressed.
CLR key	Clears last entered character when pressed once. When pressed twice, clears entire display panel under keyboard control.

3-29. Modes of Operation.

The three basic modes of operation are: test, navigate, and backup.

3-30. Test Mode.

The TEST mode contains two functions: LAMP TEST mode, in which all display segments are lit, and TEST mode, in which system operation is verified. In the LAMP TEST mode, system operation is identical to that of navigate mode except that all lamp segments and the MEM and MAL indicator lamps are lighted to verify their operation (see figure 3-7). In TEST mode, the system antenna no longer transmits or receives electromagnetic energy; instead, self-generated test signals are inserted into the electronics to verify operation. System operation automatically reverts into the backup mode during test mode. Self-test of the doppler set is done using built-in-test equipment (BITE) and all units connected and energized for normal operation. Self-test isolates failures to one of the three units of the LDNS. The computer-display unit (except for the keyboard and display) is on a continuous basis, and any failure is displayed by turn-on of the MAL indicator lamp on the computer-display unit. The signal data converter and receiver-transmitter-antenna are tested by turning the MODE switch to TEST. Failure of these components is displayed on the computer-display unit by turn-on of the MAL indicator lamp. Identification of the failed unit is indicated by a code on the display panel of the computer-display unit. Continuous monitoring of the signal data converter and receiver-transmitter-antenna is provided by the MEM indicator lamp. The MEM indicator lamp will light in normal operation when flying over smooth water. However, if the lamp remains lighted beyond 10 minutes over land or rough water, there is a malfunction in the doppler set. Then, to determine the nature of the malfunction, the operator should turn the MODE switch to TEST. As the keyboard is used, operation is verified by observing the alphanumeric readout.

3-31. Navigate Mode.

In the navigate mode (UTM or LAT/LONG position of the MODE selector), power is applied to all system components, and all required outputs and functions are provided. Changes in present position are computed and added to initial position to determine the instantaneous latitude/longitude of the helicopter. Destination and present position coordinates can be entered and displayed in UTM and latitude/longitude. At the same time, distance, bearing and time-to-go to any one of ten preset destinations are computed and displayed as selected by the FLY TO DEST thumbwheel.

3-32. Backup Mode.

In this mode, remembered velocity data are used for navigation. The operator can insert ground speed and track angle with the keyboard and the display in GS-TK position. This remembered velocity data can be manually updated through use of the keyboard and CDU DISPLAY switch in GS-TK position. When GS-TK values are inserted under these conditions, navigation continues using only these values.

3-33. Methods of Operation.

Methods of operation are discussed in the following paragraphs.

3-34. Window Display and Keyboard Operation.

In all data displays except UTM coordinates, the two fields are the left and right display windows. In UTM coordinates displays, the first field of control is the center window and the second field is the combination of the left and right displays. When pressing the KYBD pushbutton, one or other of the fields described above is under control. If it is not desired to change the display in the panel section under control, the pilot can advance to the next field of the display panel by pressing the KYBD pushbutton again. The last character entered may be cleared by pressing the CLR key. That character may be a symbol or an alphanumeric character. However, if the CLR key is pressed twice in succession, all characters in the field under control will be cleared, and that field will still remain under control.

3-35. Data Entry.

To enter a number, press the corresponding key. To enter a letter, first press the key corresponding to the desired letter. Then press a key in the left, middle, or right column corresponding to the position of the letter on the pushbutton.

EXAMPLE

To enter an L, first press L, then either 3, 6, or 9 in the right column. The computer program is designed to reject unacceptable data (for example, a UTM area of WI does not exist and will be rejected). If the operator attempts to insert unacceptable data, the display will be blank after ENT is pressed.

3-36. Starting Procedure.

a. **Lamp Test**

(1) Set MODE selector switch to LAMP TEST. All display segments and indicator lamps should be on:

(2) Turn DIM control fully clockwise, then fully counterclockwise, and return to full clockwise. All segments of the display should alternately glow bright, go off, and then glow bright.

b. **Test**.

(1) Set MODE selector switch to TEST.

NOTE

Ignore the random display of alpha and numeric characters which occurs during the first 15 seconds. Also ignore test velocity and angle data displayed after the display has frozen. A successful test cannot be accomplished until HARS has completed BIT.

(2) After approximately 15 seconds, one of the following displays will be observed in the left and right displays:

NOTE

If the MAL lamp lights during any mode of operation except LAMP TEST, the computer-display unit MODE switch should be turned first to OFF, and then to TEST, to verify the failure. If the MAL lamp remains on after recycling to TEST, enter the failure of the LDNS on DA Form 2408-13 in the aircraft log book.

DISPLAY		REMARKS
LEFT	RIGHT	
GO	No display. Display blanks (normal).	If right display is blank, system is operating satisfactorily.
GO	P	If right display is P, then pitch or roll data is missing, or pitch exceeds 90 deg. In this case, pitch and roll in the computer are both set to zero and navigation continues in a degraded operation. Problem may be in the HARS or helicopter cabling.

NOTE

If the TEST mode display is BU, MN or NG, the MODE switch should be recycled through OFF to verify that the failure is not a momentary one. If the TEST mode display is BU or MN, the data entry may be made in the UTM or LAT/LONG mode; but any navigation must be carried on with the system in the BACKUP mode.

BU	C, R, S, or H followed by a numeric code	A failure has occurred and the system has automatically switched to a BACK-UP mode of operation as follows: 1. If no true airspeed is available, last remembered velocity is being used for navigation.

DISPLAY		REMARKS
LEFT	RIGHT	
BU (cont)		1. The operator has the option of turning the MODE switch to BACKUP and entering the best estimate of ground speed and track angle. 2. If true airspeed is available, true airspeed plus remembered wind is used for navigation. The operator has the option of turning the MODE switch to BACKUP and entering his best estimate of wind speed, direction, ground speed, and track angle. The operator should update present position immediately because it is possible that significant navigation errors may have accumulated.
MN	C, R, S, or H followed by a numeric code	A failure has occurred and the BACKUP mode, used for manual navigation (MN), is the only means of valid navigation. The operator may use the computer as a dead reckoning device by entering ground speed and track data. The operator should update present position immediately because it is possible significant navigation errors may have accumulated.
NG	C, R, S, or H followed by a numeric code	A failure has occurred in the system and the operator should not use the system.
BU (cont)		
EN		The 9V battery has failed. All stored data must be reentered. This display may be cleared by pressing the KYBD pushbutton.

c. **Entering UTM DATA.** Enter the following initial data (paragraph 3-35) before navigating with the doppler:

(1) Spheroid of operation, when using UTM coordinates.

(2) UTM coordinates of present position – zone, area, easting (four significant digits), and northing (four significant digits). Latitude/longitude coordinates may be used.

(3) Variation of present position to the nearest one-tenth degree.

(4) Coordinates of desired destination – 0 through 5 and H (6 through 9 are normally used for target store locations but may also be used for destinations). It is not necessary to enter all destinations in the same coordinate system.

NOTE

It is not necessary to enter destinations unless steering information is required; unless, it is desired to update present position by overflying a destination; or, unless a present position variation computation is desired (paragraph 3-36 step e). If a present position variation running update is desired, destination variation must be entered. The operator may enter one or more destination variations to effect the variation update. It is not necessary for all destinations to have associated variations entered.

(5) Variations of destinations to be nearest one-tenth degree.

d. **Entering Spheroid and/or Variation.**

(1) MODE selector – UTM (LAT/LONG, or BACKUP may also be used).

(2) DISPLAY selector - SPH-VAR.

(3) DEST DISP thumbwheel – P, numeral, or H, as desired.

(4) KYBD pushbutton – Press. Observe display freezes and TGT STR indicator blanks. Press KYBD pushbutton again and observe left display blanks. If no spheroid data is to be entered, depress KYBD pushbutton again and proceed to step 6.

(5) Enter Spheroid data. (Example: INO.) Press keys 3 (left window blanks), 3, 5, 5, and 0. Left display should indicate INO.

(6) KYBD pushbutton – Press. Observe right display blanks. If no variation data is to be entered, press ENT key.

(7) Enter Variation data (Example: E001.2.) Press keyboard keys 2 (right window blanks), 2, 0, 0, 1, and 2 display indicates NO E 001.2. Press ENT key. The entire display will blank and TGT STR number will reappear. Display should indicate INO E 01.2.

e. **Entering Present Position or Destination In UTM.**

(1) MODE selector – UTM.

(2) DISPLAY selector – DEST-TGT.

(3) Set DEST DISP thumbwheel to P, numerical, or H, as desired.

(4) Enter present position and destination. (Example: entry of zone 31T, area CF, easting 0958, and northing 3849.)

(a) KYBD pushbutton – Press. Observe that display freezes and TGT STR indicator blanks.

(b) To enter zone 31T KYBD button – Press. Observe that center display blanks.

(c) Keys 3, 1, 7, and 8 – Press.

(d) To enter area CF, easting 0958, and northing 3849, KYBD button – Press. Observe left and right displays blank.

(e) Keys 1,3,2,3,0,9,5,8,3,8,4, and 9 – Press.

(f) ENT pushbutton – Press. Left, right, and center displays will momentarily blank and TGT STR number will appear. Displays should indicate 31T CF 09583849.

f. **Entering Present Position or Destination Variation In LAT / LONG.** The variation of a destination must be entered after the associated destination coordinates are entered (since each time a destination is entered, its associated variation is deleted). The order of entry for present position is irrevelant.

NOTE

If operation is to occur in a region with relatively constant variation, the operator enters variation only for present position, and the computer will use this value throughout the flight.

(1) MODE selector – LAT/LONG.

(2) DISPLAY selector – DEST-TGT.

(3) DEST DISP thumbwheel – P, numerical, or H, as desired.

(4) Present position or destination – Enter. (Example: Entry of N41 degrees 10.1 minutes and EO 35 degrees 50.2 minutes.) Press KYBD pushbutton. Observe that display freezes and TGT STR indicator blanks. Press KYBD pushbutton again and observe left display blanks. To enter lattitude press keys 5, 5, 4, 1, 1, 0 and 1. To enter longitude press KYBD pushbutton (right display should clear) and keys 2, 2, 0, 3, 5, 5, 0, and 2.

(5) ENT pushbutton – Press. Entire display will blank and TGT STR number will reappear. Display should indicate N41 degrees 10.1 EO 35 degrees 50.2.

g. **Entering Ground Speed and Track.**

(1) MODE selector - BACK UP.

(2) DISPLAY selector - GS-TK.

(3) Ground speed and track - Enter. (Example: Enter 131 km/h and 024 degrees.) Press KYBD pushbutton. Observe that left display freezes and TGT STR indicator blanks. To enter ground speed press keys 1, 3 and 1. Left display indicates 131. Press KYBD push-button. Control shifts to right display and right display blanks. To enter track angle press keys 0, 2, and 4.

(4) ENT pushbutton - Press. The entire display will blank, and TGT STR number will reappear. Display should indicate 131 024 degrees.

h. **Initial Data Entry**. Initial data entry variation coordinates are normally done prior to takeoff. To make the initial data entry, do the following:

(1) Present position variation - Enter (paragraph 3-36, step f).

(2) DISPLAY selector - DEST-TGT.

(3) DEST DISP thumbwheel - P. Do not press ENT key now.

(4) ENT pushbutton - Press as helicopter is sitting over or overflies initial fix position.

(5) FLY-TO DEST thumbwheel - Desired destination location.

3-37. Operating Procedures.

a. **Update of Present Position From Stored Destination.** The helicopter is flying to a destination set by the FLY TO DEST thumb-wheel (figure 3-7). When the helicopter is over the destination, the computer updates the present position when the KYBD pushbutton is pressed. This is accomplished by using stored destination coordinates for the destination number shown in FLY TO DEST window and adding to them the distance traveled between the time the KYBD pushbutton was pressed and the ENT key was pressed.

(1) DISPLAY selector - DIST/BRG-TIME.

(2) KYBD pushbutton - Press when helicopter is over the destination. Display freezes.

NOTE

If a present position update is not desired as indicated by an appropriately small value of distance to go on overflying the destination, set the DISPLAY selector to some other position. This aborts the update mode.

(3) ENT key - Press.

b. **Update of Present Position From Landmark.** There are two methods for updating present position from a landmark. Method 1 is useful if the landmark comes up unexpectedly and the operator needs time to determine the coordinates. Method 2 is used when a landmark update is anticipated.

(1) Method 1.

(a) DISPLAY selector - PP.

(b) KYBD pushbutton - Press as landmark is overflown. Present position display will freeze.

(c) Compare landmark coordinates with those on display.

(d) Landmark coordinates - Enter. If difference warrant an update.

(e) ENT key - Press if update is required.

(f) DISPLAY selector -- Set to some other position to abort update.

(2) Method 2

(a) DISPLAY selector - DEST/TGT.

(b) DEST DISP thumbwheel - P. Present position coordinates should be displayed.

(c) KYBD pushbutton - Press. Observe that display freezes.

(d) Landmark coordinates – Manually enter via keyboard.

(e) ENT key – Press when overflying landmark.

(f) DISPLAY selector – Set to some other position to abort update.

c. **Left-Right Steering Signals.** Flying shortest distance to destination from present position:

(1) DISPLAY selector – XTK-TKE.

(2) MODE SEL – UTM.

(3) To center the pointer, fly the helicopter in the direction of the course deviation bar on the horizontal situation indicator (HSI).

d. **Target Store (TGT STR) Operation.** Two methods may be used for target store operation. Method 1 is normally used when time is not available for preplanning a target store operation. Method 2 is used when time is available and it is desired to store a target in a specific DEST DISP position.

(1) Method 1.

(a) TGT STR pushbutton – Press when flying over target.

(b) Present position is automatically stored and the destination location is that which was displayed in the target store indicator (position 6, 7, 8, or 9) immediately before pressing the TGT STR pushbutton.

(2) Method 2.

(a) MODE selector – UTM or LAT/LONG, depending on coordinate format desired.

(b) DISPLAY selector – DEST-TGT.

(c) DEST DISP thumbwheel – P.

(d) KYBD pushbutton – Press when overflying potential target. Display should freeze.

NOTE

Do not press ENT key while DEST DISP thumbwheel is at P.

(e) If it is desired to store the target, turn DEST DISP thumbwheel to destination location desired and press ENT key.

(f) If it is not desired to store the target, momentarily place DISPLAY selector to another position.

e. **Transferring Stored Target Coordinates From One Location to Another.** The following procedure allows the operator to transfer stored target coordinates from one thumbwheel location to another. For example: it is assumed that the pilot wants to put the coordinates of stored target 7 into location of destination 2.

NOTE

Throughout this procedure, range, time-to-go, bearing, and left/right steering data are computed and displayed for the destination selected via the FLY TO DEST thumbwheel.

(1) DISPLAY selector – DEST-TGT.

(2) DEST DISP thumbwheel – 7.

(3) KYBD pushbutton – Press.

(4) DEST DISP thumbwheel – 2.

(5) ENT key – Press.

f. **Transferring Variation From One Location to Another.** The procedure to transfer variation data to the same location where the associated stored target coordinates have been transferred is the same as in Paragraph 3-37 (step e), except that the DISPLAY selector is placed at SPH-VAR.

g. **Dead Reckoning Navigation.** As an alternate BACKUP mode, dead reckoning navigation can be done using ground speed and track angle estimates provided by the operator.

(1) MODE selector – BACKUP.

(2) DISPLAY selector – GS-TK.

(3) Best estimate of ground speed and track angle – ebnter via keyboard.

(4) Set MODE selector to any position to abort procedure.

h. **Operation During and After Power Interruption.** During a dc power interruption, the random access memory (RAM) (stored destination and present position) data is retained by power from a 9-volt dc dry nicad battery. This makes it unnecessary to reenter any navigational data when power returns or before each flight. If the battery does not retain the stored destination data during power interruption, the display will indicate an EN when power returns. This indicates to the pilot that previously stored data has been lost and present position (spheroid/variation) and destinations must be entered. The computer, upon return of power, resets present position variation to EO 00.0-degree destination, and associated variations to a non-entered state, and remembers wind to zero and spheroid to CL6. The following data must be entered following battery failure:

(1) Enter spheroid.

(2) Enter present position vatriation.

(3) Enter present position.

(4) Enter each destination and its associated variation.

3-38. Stopping Procedure.

MODE selector – OFF.

3-38.1. AN/ASN-137 Controls, Displays, and Functions.

a. **General Description.** The AN/ASN-137 DNS uses the IP-1552G CDU for data entry and display. The CDU(figure 3-7.1) has a full alphanumeric keyboard for data entry, 13 special purpose fixed action buttons (FAB), and 8 variable action buttons (VAB). In some cases the variable action buttons are referred to as VAB 1 through VAB 8 (refer to figure 3-7.1). Only 6 of the fixed action buttons are active in this installation: NAV, FDLS, FPLN, CLR, SPC, and STR. The CDU display architecture is organized in page formats. Each page can display information on 8 separate lines. The bottom line is always the data entry scratchpad, which is 21 characters wide. The 8 VABs are arranged 4 on each side of the CDU display. The function performed by the VAB depends on the particular page displayed. VABs may be used to transfer data to or from the scratchpad to a specific location on the display or select another page to perform other functions.

b. **Control and Display Functions.** The IP1552G CDU is located in the CPG right-hand console and has fixed action and variable action pushbuttons and a full alphanumeric keyboard (figure 3-7.1). The function of each is as follows:

CONTROL/DISPLAY	FUNCTION
Display Screen	Display formats are organized as pages with 8 display lines; the bottom line is always used as the scratchpad for entering or editing data.
Keyboard	Alphanumeric keyboard is used for entering data.
Left/Right Arrows	Move the cursor one space left or right, as appropriate, per keystroke. When pressed constantly, will move the cursor at about 4 character positions per second.
Up/Down Arrows	Scroll through the waypoint dictionary pages, one page per keystroke. When constantly pressed, will scroll through all dictionary pages at about one page per second.
BRT Control	Adjust display brightness.
CLR	If pressed in response to

	an ERROR prompt in the scratchpad, will clear the error prompt and position the cursor at the first detected data entry error. If pressed a second time, will clear the entire scratchpad. If no ERROR prompt is present when CLR is pressed, it will clear the entire scratchpad.
SPC	Enters a blank space character.
STR	Stores DNS present position in storage locations 16 through 19 in circular rotation.
FPLN	Displays the first (H-1-2) of 7 waypoint dictionary pages. Dictionary pages may then be scrolled using the Up/Down Arrow keys.
NAV	Displays NAV top level page. Pressing the NAV FAB will override all other display pages and return the CDU display to the NAV top level page.
FDLS	Used to access the DNS page. DNS FDLS tests are initiated from this page.
COM	Not active.
IFF	Not active.
ATHS	Not active.
TGT	Not active.
CODE	Not active.
DATA	Not active.

3-38.2. AN/ASN-137 Modes of Operation.

a. **General.** There are four modes of operation for the AN/ASN-137 and IP-1552G CDU. They are: navigation, backup, hover bias calibration (HBCM), and test (On Command and Continuous). When electrical power is first applied to the helicopter, the CDU is powered and the NAV top level page is displayed as shown in figure 3-7.2 The DNS is not powered at this time.

NOTE

All data and messages shown in displays are typical representations.

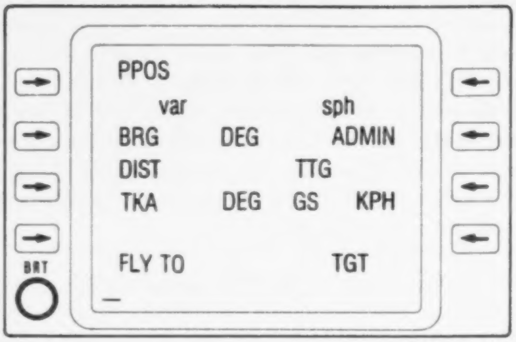


Figure 3-7.2. Power Up Display, NAV Top Level - DNS PWR OFF

b. **Navigation Mode.** This is the initial power-up mode of the DNS. In navigation mode, power is applied to all DNS components. Computed present position data is derived by the DNS computer from doppler radar data. This is the most accurate navigation mode.

c. **Backup Mode.** The backup mode is manually selected by the CPG. Backup mode is usually selected for only one of two reasons: DNS FDLS has detected a failure of the doppler receiver/transmitter antenna or a heading input failure. In this mode the DNS computer uses the last valid doppler radar ground speed for navigation calculations. Dynamic doppler radar velocities will not be available. The heading attitude reference set (HARS) will go into free inertial when the DNS is in backup mode. The CPG can change the ground speed used by entering his computed or best estimation of ground speed on the NAV top level page. Ground speed can only be entered by the CPG when the DNS is in backup mode.

d. **Hover Bias Calibration Mode.** The HBCM calibrates the DNS system for small velocity errors that may be present in the doppler receiver/transmitter subsystem. The velocity bias corrections computed by the DSN computer and are applied to all subsequent doppler radar velocities.

The velocity bias (error), when present, will be most noticeable when the helicopter is at a hover or slow speeds. The reason is that at a hover the velocity error, although small, is about the same amount as the actual helicopter velocity. When HBCM is selected, the CPG can manually start and stop the calibration. If a calibration NO-GO status is displayed at the conclusion, a recalibration may be restarted by the CPG. If a GO calibration is computed, the bias velocities will automatically be stored and applied continuously to all subsequent navigation computations.

e. **Test Mode.** The DNS and CDU have both Continuous and On Command FDLS tests. The DNS continuous test checks the doppler receiver/transmitter antenna (RTA), and doppler signal data converter computer (SDCC). The CDU monitors its own internal functions and the dedicated 1553B mux bus between the CDU and DNS SDCC. If a failure is detected by the Continuous test, the CDU will display the prompt √ FDLS on line 6 of the NAV top level page. The CPG can then display system status by pressing the FDLS FAB. The CPG can initiate the On Command test from the FDLS page. The On Command test initiates a full DNS subsystem component test. If no failures are detected, the CDU will display CDU/DNS GO. After 5 seconds the CDU will display the pitch, roll, and inertial heading, in degrees, currently being used by the DNS. The pitch and roll angles will reflect the actual orientation of the helicopter; on level ground, pitch will be approximately 4.5 to 5.5 degrees, and roll should be about 0.0. If the helicopter has a lean due to cyclic or pedal inputs, this will be reflected in the roll angle displayed. The heading value displayed is the inertial heading of the helicopter; HSI/RMI heading plus or minus the magnetic variation.

3-38.3. AN/ASN-137 Displays.

a. **General.** The CDU display architecture is organized into page formats. Each page consists of 8 display lines. The first seven are 22 characters wide for displaying data. The bottom (eighth) line is 21 characters wide and is a scratchpad for entering or editing data. Individual pages may display navigation data, display failure messages, or indicate selectable functions. The CDU displays are categorized into 5 basic page formats: NAV top level, ADMIN, FDLS, HBCM, and FPLN.

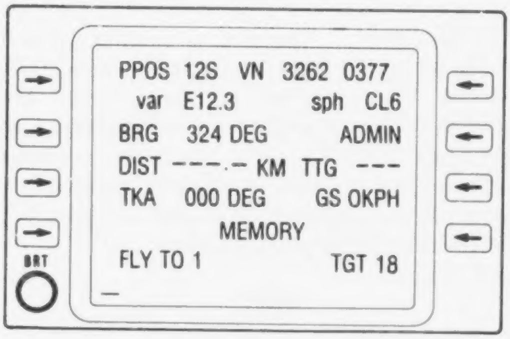
The CDU display will automatically revert back to the NAV top level page based on two basic rules:

Rule 1. - The CDU will revert to the NAV top level page automatically from the ADMIN or any of the FPLN (waypoint dictionary) pages after 30 seconds if there are no characters in the scratchpad. The 30 second timer is reset each time a FPLN page is scrolled with the Up/Down arrow when the scratchpad contains no data. Remember: If the scratchpad contains any data the display will NOT automatically revert back to the NAV top level page.

Rule 2. - The CDU will revert to the NAV top level page automatically from the ADMIN page 3 seconds after pressing any of the following VABs: PWR ON or PWR OFF, BACKUP, MODE UTM or MODE L/L, and DISPL KPH or DISPL KTS.

If the HBCM VAB on the ADMIN page or FDLS FAB is pressed the CDU will NOT revert automatically back to the NAV top level page. The NAV top level page can be manually selected at any time from any page by pressing the NAV FAB.

b. **NAV Top Level Page.** The NAV top level page as shown in figure 3-7.2 will be displayed approximately 30 seconds after aircraft electrical power is applied. No data will be displayed until the DNS power is turned on. The DNS is powered by pressing the ADMIN VAB and then pressing the PWR OFF VAB on the ADMIN page. The DNS indicates a failure if it is powered and the HARS is OFF or in the first 90 seconds of alignment. When the DNS is powered, the NAV top level page will be as shown in the example in figure 3-7.3. The display shows the following:



```
PPOS 12S  VN  3262 0377
  var  E12.3      sph  CL6
BRG   324 DEG       ADMIN
DIST ---.– KM  TTG  ---
TKA   000 DEG     GS 0KPH
         MEMORY
FLY TO 1           TGT 18
_
```

MM01-218-4A

Figure 3-7.3. NAV Top Level Page- PWR ON.

NOTE

Refer to Data Entry and Operating Procedures, paragraphs 3-38.4 and 3-38.5 as necessary.

Line 1. - PPOS represents the current DNS computed presented position in either UTM or LAT/LONG. The PPOS data may be changed or edited.

Line 2. - var and sph are the magnetic variation and spheroid associated with the PPOS. var and sph may be changed or edited.

Line 3. - BRG is the direct bearing to the destination specified in the FLY TO position on line 7. ADMIN is a VAB label that selects the page for the various administrative functions associated with the DNS.

Line 4. - DIST and TTG are the distance and time-to-go (at current ground speed) to the destination specified in the FLY TO position. DIST will display in either kilometers or nautical miles, independent of the PPOS data, as selected on the ADMIN page.

Line 5. - TKA and GS are the computed track angle and ground speed. Ground speed may be displayed in either kilometers per hour (KPH) or knots as selected on the ADMIN page. The units for both DIST and GS are same for a given selection: KM and KPH, or NM and KTS.

Line 6. - This is the CDU and DNS status line. The line may be blank or display MEMORY, BACKUP, or √FDLS. A display on this line indicates that the DNS has either lost radar lock: MEMORY; the CPG has manually selected BACKUP; or the Continuous FDLS test has detected a fault in the CDU/DNS system.

Line 7. - FLY TO shows the selected destination to which the DNS is navigating. The displayed value can be any of the 20 locations in the FPLN dictionary; H through 19. The FLY TO number can be changed. TGT displays the storage location that will be used next when the STR FAB is pressed; locations 16 to 19 are used repetitively.

Line 8. - This is the scratchpad line for data entry.

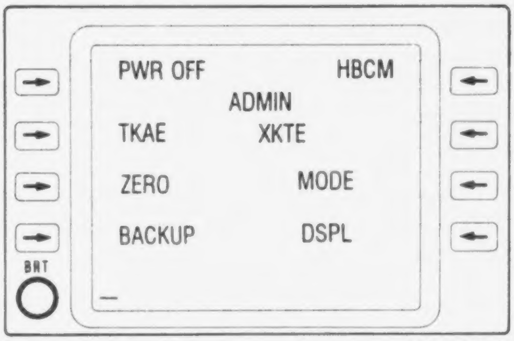
c. **ADMIN Page.** The ADMIN page, as shown in figures 3-7.4 and 3-7.5, is used to select other modes of DNS operation and administrative DNS management and display functions. The ADMIN page has the following:

Line 1. - PWR OFF or PWR ON is an alternate action VAB powering the DNS. HBCM selects the Hover Bias Calibration Mode page.

Line 2. - Identifies the ADMIN.

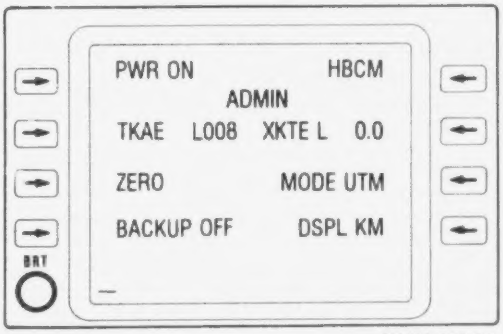
Line 3. - TKAE is a data display only showing the Track Angle Error. The L or R character specifies which direction to steer to reduce the TKAE to zero. XTKE is a data display only showing the Cross Track Error in kilometers or nautical miles.

Line 4. - Blank.



PWR OFF HBCM
ADMIN
TKAE XKTE
ZERO MODE
BACKUP DSPL
_

Figure 3-7.4. ADMIN Page - PWR OFF.



PWR ON HBCM
ADMIN
TKAE L008 XKTE L 0.0
ZERO MODE UTM
BACKUP OFF DSPL KM
_

Figure 3-7.5. ADMIN Page - PWR ON.

Line 5. - ZERO is a function which permits zeroizing the CDU or DNS memory. The specific system to zero is accomplished by entering either CDU or DNS in the scratchpad and pressing the Zero VAB. Zeroizing the CDU will clear all FPLN dictionary storage locations to default values. Zeroing the DNS will cause loss of HBCM data. MODE L/L or MODE UTM is an alternate action VAB selecting the coordinate system for display and data entry of coordinate data.

Line 6. - Blank.

Line 7. - BACKUP ON or BACKUP OFF is an alternate action VAB selecting DNS BACKUP mode. DSPL KM or DSPL NM is an alternate action VAB that permits switch of DIST and GS only from KM/KPH to NM/KTS and back.

Line 8. - Scratchpad.

d. **HBCM Page**. The HBCM page, as shown in figure 3-7.6, is used to START and STOP the bias calibration of the DNS. The 30-second automatic reversion to NAV top level page is disabled when HBCM is selected. Refer to paragraph 3-38.6-d for HBCM operating procedures. The display has the following:

Line 1. - START is used to activate the HBCM calibration. HBCM identifies the page. STOP is used to terminate the calibration.

Line 2. - HBCM READY indicates the DNS is ready to start the calibration sequence. HBCM ACTIVE, HBCM GO, and HBCM NO-GO will also be displayed on the line as appropriate..

Line 3. - Error messages pertinent to an HBCM condition are displayed on this line.

Line 4. - Blank.

Line 5. - TIME XX:XX indicates elapsed time in minutes/seconds for DNS computations of the bias calibration. The timer will stop while the DNS is in memory during the bias calibration.

Line 6. - Blank.

Line 7. - Blank.

Line 8. - Scratchpad. Not used in HBCM.

e. **FDLS Page.** The FDLS page, as shown in figure 3-7.7, is used to initiate the On Command FDLS test function. The FDLS page is selected by pressing the FDLS FAB. The FDLS page has the following display.

Line 1 through Line 6. - Blank.

Line 7. - TEST initiates the On Command FDLS test for the CDU and DNS.

Line 8. - Scratchpad. Not used in FDLS.

f. **FPLN Page.** The FPLN FAB selects the waypoint coordinate dictionary pages. The first FPLN page displayed when the FPLN FAB is pressed is determined by the FLY TO selection on the NAV top level page. A FPLN page is shown in figure 3-7.8.

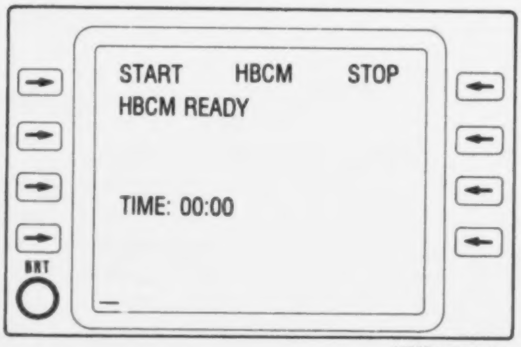


Figure 3-7.6. HBCM Page.

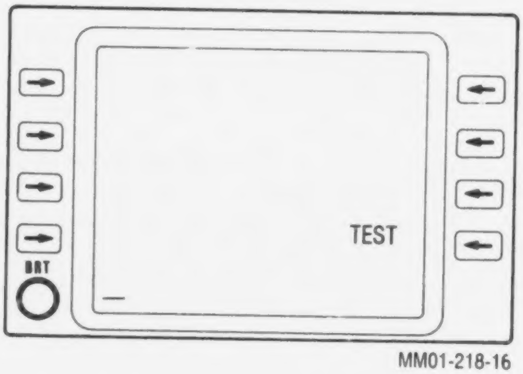
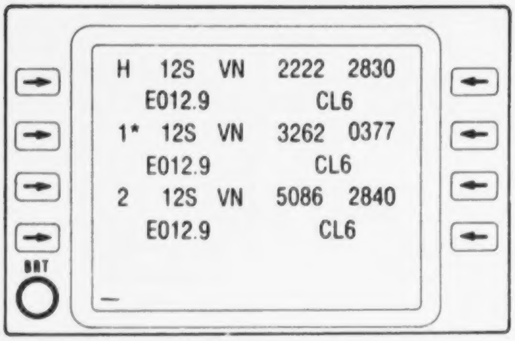


Figure 3-7.7. FDLS Page.



MM01-218-15

Figure 3-7.8. FPLN Dictionary Page.

The waypoints are organized on pages as follows:

Page	Waypoints
1	Home 1,2
2	3, 4, 5
3	6, 7, 8
4	9, 10, 11
5	12, 13, 14
6	15, 16, 17
7	18 and 19.

The Up/Down arrow keys can be used to scroll through the FPLN dictionary pages. An * is shown immediately after the storage location currently being used for FLY TO computations and it cannot be changed until some other location is chosen to FLY TO. The page has the following data organization:

Line 1. - Displays the coordinate location data.

Line 2. - Displays the magnetic variation and spheroid associated with the coordinate data above it.

Line 3. - Displays the next coordinate location data.

Line 4. - Displays the magnetic variation and spheroid associated with the coordinate data above it.

Line 5. - Displays the next coordinate location data.

Line 6. - Displays the magnetic variation and spheroid associated with the coordinate data above it.

Line 7. - Blank.

Line 8. - Scratchpad for data input.

3-38.4. Data Entry Procedures.

The CDU display present position can be manually updated, waypoint locations stored, FLY TO destination selected and other data entries made via the CDU keyboard. Keyboard entries appear on the scratchpad. The CDU checks the validity of all data entered before it transfers the data to the appropriate location on the display.

a. **General Data Entry and Error Correction.** General data entry and error correction procedures follow the example of present position (PPOS), magnetic variation (var) and spheroid (sph) manual update (Mode UTM) on the Nav top level page.

DATA ENTRY EXAMPLE

(1) Use the keyboard keys (see figures 3-7.1) to enter the following into the scratchpad:

12SVN32620377E12C5_

NOTE

The last character (5) is deliberately erroneous.

Observe that each character appears on the scratchpad, left justified, as it is entered.

(2) Press PPOS. Observe that the scratchpad display alternates between the data entered and the prompt ERROR.

(3) Press CLR FAB. Error prompt is cleared and the data in the scratchpad has the cursor positioned under the error as shown below:

12SVN32620377E12C5_

NOTE

The cursor is positioned under the first error detected. If more than one error is detected, the cursor moves left to right to the next error. Continue editing until all data is corrected.

(4) Enter 6. Observe that 5 changes to 6.

(5) Press PPOS. Observe that the scratchpad is now blank and lines 1 and 2 of the CDU display appear as follows:

```
PPOS  12S  VN  3262  0377
   var  E012.0          sph  CL6
```

3-38.5. Power Up Procedures.

The steps in this procedure list actions required (and expected CDU display results) to ready the DNS for flight. Refer to Data Entry or Operating Procedures, paragraphs 3-38.4 and 3-38.6, for detailed techniques and parameters of such actions as:

UTM or L/L Coordinate Entries
Hover Bias Calibration
General Data Entry and Error Correction

a. Display Check.

(1) Rotate BRT control fully clockwise. Observe brightness change.

(2) Adjust BRT control for best visibility of display.

b. DNS Power On.

(1) Press ADMIN. Observe that the ADMIN Page is displayed.

(2) Press PWR OFF. Observe PWR OFF changes to PWR ON for three seconds then CDU display changes to NAV top level present position page.

NOTE

- If PWR OFF changes to PWR - - - or the NAV top level present position page is not displayed after approximately three seconds, the DNS has failed.
- If the RAM battery has failed, all navigation data in the SDCC memory is lost and the following prompts are automatically displayed on the FDLS page as shown in figure 3-7.11.

DNS RAM ERASED
DNS IN REMEMBERED VEL
END OF LIST

c. **FDLS TESTS.**

(1) Press FDLS FAB. Observe that the Continuous Test Results - FDLS Page is displayed, as shown in figure 3-7.9.

(2) Press TEST. Observe that NAV SYS TEST IN PROG is displayed until the test is complete and data is available for DNS test status.

(3) If a GO message is displayed (figure 3-7.10), press the NAV FAB.

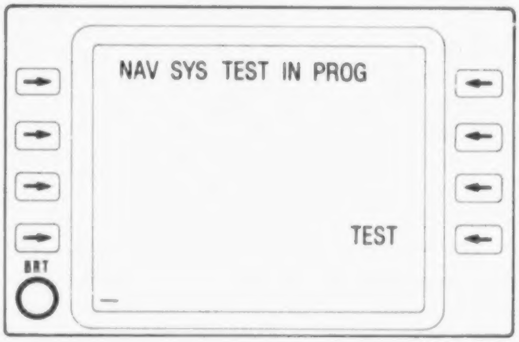
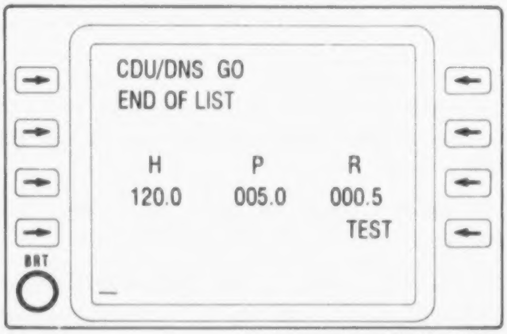

NAV SYS TEST IN PROG

Figure 3-7.9. FDLS Test In Progress (Normal Mode).


CDU/DNS GO
END OF LIST

H	P	R
120.0	005.0	000.5

Figure 3-7.10. FDLS Status Page - On Command Test Results GO.

NOTE

The heading, pitch and roll values are calculated and displayed approximately five seconds after the GO message.

d. **Selecting Mode UTM or L/L and DSPL KM or KTS.** If the operator desires to switch between Mode UTM and Mode L/L or DSPL KM and DSPL KTS, perform the following:

(1) Press ADMIN. Observe that the ADMIN page is displayed.

(2) Press MODE UTM to change to MODE L/L or vice versa.

(3) Press DSPL KM to change to DSPL KTS or vice versa.

e. **Coordinate Entries for FPLN dictionary.**

(1) Press FPLN FAB. Observe that FPLN dictionary page is displayed.

(2) Use up and down arrow keys to scroll to FPLN dictionary page 1 (locations H, 1 and 2).

(3) Use the keyboard to enter H coordinate data into scratchpad.

UTM EXAMPLE

11SGQ52184911E14.8C6

LAT/LONG EXAMPLE

N7425.9W12057.6E10.5

(4) Press left hand VAB of desired storage location (H). Observe that the scratchpad is now blank and the entered data now appears on lines 1 and 2 (H location) of CDU display.

(5) Repeat steps 3 and 4, entering data and pressing appropriate VAB for each waypoint to be entered. Use Down and Up arrow keys to scroll through FPLN dictionary pages as desired.

(6) Press NAV FAB to display the NAV top level page or allow time out to automatically revert to NAV top level page.

f. **Coordinate Entries for Present Position (PPOS).** Coordinate entries for present position data (including magnetic variation and spheroid) may be entered by two different methods.

Method 1 - Manual Keyboard Entry

(1) Use the keyboard to enter coordinate data into the scratchpad.

(2) Press VAB 1. Observe that the coordinate data now appears on lines 1 and 2 of NAV top level page display.

Method 2 - Updating to a Stored Waypoint.

(1) Enter the number of the stored waypoint into the scratchpad.

(2) Press FLY TO. Observe that waypoint number now appears after FLY TO.

(3) Press top right VAB. Observe that FLY TO changes to UPDATE TO.

NOTE

The procedure can be aborted by pressing top right VAB.

(4) Press FLY TO. Observe that the present position coordinate data is now updated to that of the stored waypoint.

3-38.6. Operating Procedures.

a. When first powered up the DNS is in Navigation Mode. Most functions and modes of operation are accessed via the NAV top level present position page. Exceptions are the On Command Test and FPLN dictionary Pages.

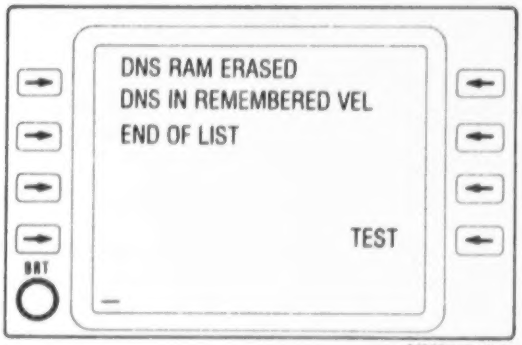
(1) Press ADMIN. Observe that the ADMIN page is displayed.

(2) Press PWR OFF. Observe PWR OFF changes to PWR ON and CDU display changes to NAV top level present position page after 3 seconds.

NOTE

If PWR OFF changes to PWR – – – or the NAV top level present position page is not displayed after approximately three seconds, the DNS has failed.

If FDLS Status Page (figure 3-7.11) is displayed, the RAM battery has failed. The DNS RAM battery test is only performed at power on. The On Command FDLS test can be initiated from this page by pressing TEST. Refer to On Command Test (FDLS) part of this paragraph for detailed procedures.



DNS RAM ERASED
DNS IN REMEMBERED VEL
END OF LIST
TEST

MM01-218-5

Figure 3-7.11. FDLS Page - Continuous Test Results.

b. **CDU or DNS Memory Zeroize**. The DNS memory zeroize function is used for maintenance purposes only after the CDU or signal data converter has been replaced. The CDU memory zeroize resets all flightplan dictionary page waypoints to bogus default values. This is done from the NAV top level present position page as follows:

(1) Press ADMIN. Observe that the ADMIN page is displayed.

(2) Enter CDU on the scratchpad.

(3) Press ZERO.

(4) Press FPLN FAB. Observe that all locations on the FPLN dictionary page displayed contain the similar default values:

31T BV 6355 8711
E 000.0 sph CL6

(5) Using the up and down arrow keys, scroll through all FPLN dictionary pages, observing that all location contain the default value.

(6) Press NAV. Observe that the NAV top level present position page is displayed with default data next to the captions.

c. **BACKUP Mode**. In the BACKUP mode, the last remembered radar velocities become the source for navigating.

This mode provides the capability to the operator of manually entering groundspeed (GS) and track angle (TKA) via the NAV top level present position page.

The BACKUP mode must be manually accessed. To operate the BACKUP mode do the following:

(1) Press ADMIN. Observe that the ADMIN page is displayed.

(2) Press BACKUP OFF. Observe that BACKUP OFF changes to BACKUP ON.

(3) Enter GS data into the scratchpad and press VAB 7. Observe the data is now displayed on line 5 next to GS.

(4) Enter TKA data into the scratchpad and press VAB 3. Observe that the data is now displayed on line 5 next to TKA.

d. **Hover Bias Calibration Mode (HBCM)**. In HBCM the DNS determines the hover bias velocities in both the longitudinal and lateral axes of the DNS. The computed bias velocity corrections are applied to all future DNS hover velocity computations. HBCM is accessed via the NAV top level present position and ADMIN pages.

NOTE

Hover bias calibration only needs to be performed when the signal data converter or receiver/transmitter antenna has been replaced.

(1) Press ADMIN. Observe that the ADMIN page is displayed.

(2) Press HBCM. Observe that the HBCM page (figure 3-7.6) is displayed.

NOTE

- If line 2 of the HBCM page does not display HBCM READY, the DNS has failed.
- The time indicated on line 5 of the HBCM page increments only when DNS is performing hover bias computations. If the DNS goes into memory mode, the time display halts until the signal from the RTA is sufficient for DNS computations.

(3) Press START. Observe that on line 2 HBCM READY changes to HBCM ACTIVE and on line 5 the time displayed begins incrementing.

NOTE

The calibration continues until the CPG presses STOP to stop it. When the calibration is stopped, the mode status will be displayed. Allow the calibration to run for at least two minutes but not more than 8.2 minutes.

(4) Press STOP. Observe that the time display freezes and a mode status message is displayed on line 2. If applicable, DNS error messages will be displayed on lines 3 and 4. The DNS indicates the HBCM update was accepted when an HBCM GO is displayed or not accepted when an HBCM NO-GO message is displayed along with a description of the exceeded limit(s) on other lines. Possible DNS error messages are:

TIME BELOW 2 MIN
TIME EXCEEDED 8.2 MIN
BIAS EXCEEDS 0.3 KTS
EXCESSIVE MEM CONDITION

NOTE

If a NO-GO condition is detected, a recalibration can be initiated by pressing START again. This will zero the timer and allow for additional bias velocities calculations.

(5) Press the NAV FAB to exit the HBCM. Observe the CDU displays the NAV top level page.

e. **MODE UTM or L/L**. This is an alternate action function which toggles PPOS and waypoint dictionary coordinate displays between UTM and LAT/LONG. This is done from the NAV top level present position page as follows:

(1) Press ADMIN. Observe that the ADMIN page is displayed.

(2) Press MODE UTM to change to MODE L/L or vice versa.

f. **DISPLAY KM or KTS**. This is an alternate action function which toggles the DIST and GS displays between KM and KPH or NM and KTS respectively. This is done from the Nav top level present position page as follows:

(1) Press ADMIN. Observe that the ADMIN page is displayed.

(2) Press DSPL KM to change to DSPL KTS or vice versa.

g. **Present Position (PPOS) Updates to a Stored Waypoint Coordinate**. PPOS updates to a stored waypoint coordinate are as implemented from the NAV top level present position page. When overflying a waypoint, do the following:

NOTE

A flashing UPDATE SPHEROID message will appear on the scratchpad if the FLY TO waypoint selected has a different spheroid than the current present position data.

(1) Press VAB 5. Observe PPOS data freezes and FLY TO changes to UPDATE TO. The DNS continues to compute aircraft present position.

(2) Press FLY TO to complete an update to the position of the waypoint plus any offset distance traveled following the initiation of a PPOS update.

(3) To reject an update (abort), press either top right VAB again or NAV FAB.

NOTE

Follow either an acceptance or rejection of an update the CDU displays FLY TO and resumes displaying DNS computed PPOS and status data dynamically.

i. **Present Position (PPOS) updates to an unstored waypoint**. PPOS updates to an unstored waypoint are implement from the NAV top level present position page as follows:

(1) Press PPOS. Observe PPOS changes to UPDT and display freezes. This allows for comparison of DNS computed present position location with a known present position location.

NOTE

This type of PPOS update does not require that the aircraft remain in a hover to update the present position. This type of update also provides for position compensation for any distance traveled following a PPOS update.

(2) To complete the PPOS update to a known value, the operator enters the desired present position into the scratchpad and presses UPDT or:

(3) Rejects (aborts) the PPOS update by pressing NAV FAB.

NOTE

Following either an acceptance or rejection of a PPOS update, the CDU resumes displaying DNS computed PPOS and status data dynamically.

j. **FLY TO Destination Selection**. The number next to the FLY TO caption on line 7 specified which prestored waypoint the DNS is to navigate to. Valid FLY TO entries include values 1 - 19 and 0 or H. H and 0 are synonymous.

Enter a FLY TO destination as follows:

(1) Enter desired prestored waypoint value on scratchpad.

(2) Press FLY TO. Observe that the entered value now appears next to FLY TO and the scratchpad is now blank.

k. **UTM Coordinate entries for Waypoint Dictionary**. UTM coordinate entries, including magnetic variation and spheroid, may be entered into the waypoint coordinate. The following is a typical format to be used when entering UTM coordinates, magnetic variation and spheroid data in the CDU scratchpad:

11SGQ52184911E14.8C6

Where 11S = Gird zone identifier
GQ = UTM 100 KM-square identifier
5218 = 52.18 KM Easting within GQ
4911 = 49.11 KM Northing within GQ
E14.8 = Magnetic variation
C 6 = Spheroid Identifier of CL6

A complete entry of UTM coordinates, magnetic variation and spheroid data is not required under all circumstances. Refer to Table 3-1 for partial data entry. When a incomplete set of data is entered into the CDU scratchpad:

Rule 1 - Order of Entry. The order of entry for UTM coordinates, magnetic variation and spheroid remains the same regardless of which parameters are or are not entered. They are: grid zone identifier, 100 KM identifier, Easting/Northing; magnetic variation; spheroid. Data entered into the scratchpad is always left justified.

Rule 2 - Spheroid Change. The following character string entries are required for sph data:

SPHEROID	CHARACTER STRING ENTRY	AUTOMATIC DISPLAY
AUSTRALIAN	AU	AU0
BESSEL	BE	BE0
EVEREST	EV	EV0
INTERNATIONAL	IN	IN0
CLARKE 1880	C0	CL0
CLARKE 1886	C6	CL6
*MALAYAN	MA	MA0

* Currently not utilized

l. **UTM Coordinate Entries for Present Position**. When an incomplete set of UTM coordinates, magnetic variation and spheroid are entered into PPOS, refer to Table 3-2 for exceptions to waypoint dictionary entries.

TABLE 3-1. WAYPOINT DICTIONARY - PARTIAL ENTRY RULES

PARTIAL DATA ENTRIES	REQUIRED CHANGES TO OTHER DATA				
	GRID ZONE	100KM ID	EASTING/ NORTHING	MAGNETIC	SPHEROID
GRID ZONE		NOT AFFECTED	CHANGE	NOTE 1	NOTE 1
100KM ID	NOTE 1		CHANGE	NOTE 1	NOTE 1
EASTING/	NOTE 1	NOTE 1	CHANGE NORTHING	NOTE 1	NOTE 1
NORTHING	NOTE 1	NOTE 1	CHANGE EASTING	NOTE 1	NOTE 1
MAGNETIC VARIATION	NOT AFFECTED	NOT AFFECTED	NOT AFFECTED	NOTE 2	NOT AFFECTED
SPHERIOD		NOT AFFECTED	NOT AFFECTED	NOT AFFECTED	NOT AFFECTED

NOTE 1: If data for this parameter is not entered, its value defaults to the values associated with PPOS.

NOTE 2: The character E or W must preceed numeric values for magnetic variation. Leading and trailing zeros are not required for magnetic variation. Entering a hyphen (-) sets the magnetic variation to no computed data.

TABLE 3-2. PPOS - PARTIAL ENTRY RULES

PARTIAL DATA ENTRIES	REQUIRED CHANGES TO OTHER DATA				
	GRID ZONE	100KM ID	EASTING/ NORTHING	MAGNETIC	SPHEROID
GRID ZONE		CHANGE	CHANGE	NOT AFFECTED	NOT AFFECTED
100KM ID	NOT AFFECTED		CHANGE	NOT AFFECTED	NOT AFFECTED
EASTING/	NOT AFFECTED	NOT AFFECTED	CHANGE NORTHING	NOT AFFECTED	NOT AFFECTED
NORTHING	NOT AFFECTED	NOT AFFECTED	CHANGE EASTING	NOT AFFECTED	NOT AFFECTED
MAGNETIC VARIATION	NOT AFFECTED	NOT AFFECTED	NOT AFFECTED	NOTE 1	NOT AFFECTED
SPHERIOD		NOT AFFECTED	NOT AFFECTED	NOT AFFECTED	NOT AFFECTED

NOTE 1: The character E or W must preceed numeric values for magnetic variation. Leading and trailing zeros are not required for magnetic variation. Entering a hyphen (-) sets the magnetic variation to no computed data.

m. **CDU Validity Checks for UTM Coordinate Data**. The CDU checks the parameters of all data entered through the scratchpad. Any non-valid characters are flagged as erroneous. Valid parameters are as follows:

Grid Zone

1 - 60 for the first two characters.
C - H, J - N and P - X for the third character.

UTM Identifier

A - H, J - N and P - V for the most significant character.

Magnetic Variation

E or W and 0 - 180.0 degrees

Spheroid

AU, BE, EV, IN, C0, C6 and MA. MA is not currently utilized.

FLY TO

1 - 19 and H and 0. H and 0 are synonymous.

n. **LAT/LONG Coordinate Entries for Waypoint Dictionary**. LAT/LONG coordinates, including magnetic variation, may be entered into the waypoint coordinates as a single character string. The following is a typical format used when entering LAT/LONG coordinates and magnetic variation.

N7425.9W12057.6E10.5

Where N7425.9 = 74 degrees 25.9 minutes North Latitude
W12057.6 = 120 degrees 57.6 minutes West Longitude
E10.5 = 10.5 degrees East Magnetic Variation

When LAT/LONG and magnetic variation are all entered the required sequence is: latitude, longitude then magnetic variation.

A complete entry of LAT/LONG coordinates and magnetic variation data is not required under all circumstances. Data entered in the scratchpad is always left justified. The following rules apply when an incomplete set of LAT/LONG coordinates and magnetic variation data is to be entered into the CDU scratchpad.

NOTE

Leading zeros are required when entering degrees or minutes of latitude and longitude, i.e., N0905.5W01010.3 represents an entry of 9 degrees 5.5 minutes North latitude and 10 degrees 10.3 minutes West longitude.

Rule 1 - Latitude Range of Degrees. South latitude range for entering degrees is 00 - 80. North latitude range for entering degrees is 00 - 84.

Rule 2 - Longitude Range of Degrees. The range for entering degrees is 000 - 180.

Rule 3 - Latitude Change. A change in latitude must be accompanied by a change in longitude. Entry of magnetic variation is optional. If magnetic variation is not entered, its value defaults to the value associated with present position.

Rule 4 - Magnetic Variation Change. A change can be made to magnetic variation without changing LAT/LONG coordinate data or affecting their values.

o. **LAT/LONG Coordinate Entries for Present Position (PPOS)**. When an incomplete set of LAT/LONG coordinates and magnetic variation is entered into PPOS, the following exception applies:

NOTE

A change in latitude must be accompanied by a change in longitude. Magnetic variation remains unchanged.

p. **CDU Validity Checks for LAT/LONG Coordinate Data**. The CDU checks the parameters of all data entered into the scratchpad. Any non-valid characters are flagged as erroneous. Valid parameters are as follows:

PPOS Latitude 1st Characater
N or S only.

PPOS Latitude Degrees
00 - 84 for North latitude degrees
00 - 80 for South latitude degrees

PPOS Minutes
00.0 - 59.9

PPOS Longitude 1st Character
E or W only

PPOS Longitudinal Degrees
000 - 180

PPOS Longitude Minutes
00.0 - 59.9

Magnetic Variation
E or W and 0 - 180.0 degrees

FLY TO
1 - 19 and H or 0. H and 0 are synonymous.

q. **Waypoint Dictionary Pages and Transfer Functions**. Up to 20 waypoints can be entered into the waypoint dictionary at one time. The waypoint dictionary pages are accessed via the FPLN FAB. If the CPG desires to change display modes (UTM or LAT/LONG) before making entries into the waypoint dictionary, perform steps 1 and 2. If the mode does not need to be changed, go to step 3.

(1) Press ADMIN. Observe that the ADMIN page is displayed.

(2) Press MODE UTM. Observe that MODE UTM changes to MODE L/L or vice versa and after three seconds the NAV top level present position page is displayed

(3) Press the FPLN FAB. Observe that FPLN waypoint dictionary page 1 is displayed (waypoints home, 1 and 2).

NOTE

Refer to UTM or LAT/LONG coordinate entries for waypoint dictionary paragraphs for entry details. Refer to CDU validity checks for UTM or LAT/LONG coordinate data for data entry parameters.

(4) Enter the desired coordinates into the scratchpad.

(5) Press VAB adjacent to the desired location (waypoint number). Observe that the scratchpad is now blank and the data appears at the desired waypoint location.

r. The CDU allows for the transfer of coordinate data from one waypoint to another. To transfer waypoints, set the CDU to Mode UTM and follow the example.

EXAMPLE

(1) Press FPLN FAB. Observe that waypoint dictionary page 1 (home, 1 and 2) is displayed.

(2) Enter 12SWN00000000E12C6 into the scratchpad.

(3) Press VAB 1. Observe that the home waypoint location now displays:

```
12S   WN        0000   0000
  E012.0            CL6
```

and the scratchpad is now blank.

(4) Press VAB 5. Observe that the data in the home location is unchanged and the scratchpad now displays the data entered in step 2.

(5) Press down arrow key. Observe that waypoint dictionary page 2 (locations 3, 4 and 5) are now displayed.

(6) Press VAB 1. Observe that location 3 now contains the same data as the home location.

s. **Target Storage**. The DNS target store function operates similarly to the AN/ASN-128 target function. To perform this function, press the STR FAB. This will store DNS PPOS coordinate data, magnetic variation and spheroid data values into the waypoint number designated on line 7 of the NAV top level present position page. The TGT STR number automatically increments to the next higher number after each storage function until it reaches 19, then the counter will reset to 16.

i.e., TGT 17 specified that at the time the STR FAB was pressed, the instantaneous DNS PPOS data was stored into waypoint number 17.

t. **On Command Test (FDLS)**. The On Command Test is the manually initiated portion of the CDU and DNS fault detection and location system (FDLS). Refer to Modes of Operation (Aircraft with AN/ASN-137) paragraph. If the continuous test causes an FDLS message to be displayed on line 7 of the NAV top level present position page do the following:

(1) Press the FDLS FAB. Observe that the CDU/DNS system status is displayed as shown in Figure 3-7.12.

NOTE

An END OF LIST message is displayed following the last message (GO or NO-GO). If there are more than three malfunctions detected, use the Down and Up arrow keys to scroll through the display pages.

One or more of the following continuous test messages may be displayed:

DNS RAM ERASED

PROG PLUG NOT CONNECTED
or PROPERLY PROGRAMMED

RTA NOT CONNECTED

DNS IN REMEMBERED VEL

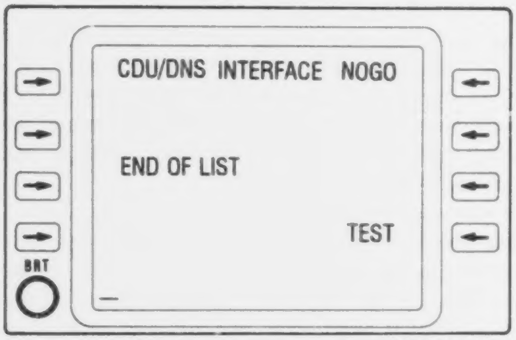


Figure 3-7.12. FDLS Status Page - ON COMMAND Test Results NO-GO.

GS/TKA ENTRY ENABLED

CDU/DNS INTERFACE NO-GO

The on command test GO/NO-GO self test can be initiated any time the FDLS page is displayed. It is not necessary to wait for an √ FDLS error message to be displayed before pressing the FDLS FAB to display the FDLS page. The GO/NO-GO self test is comprised of the following internal tests:

1. PROM Checksum verification
2. RAM read/write test
3. Limited non-volatile memory retention check.
4. Display hardware BIT
5. 1553B terminal BIT

Initiate the On Command test as follows:

(2) Press TEST. Observe that DNS SYSTEM TEST IN PROG is displayed until the test is complete and data is available for DNS test status. The GO or NO-GO status is then displayed. The following is a list of possible NO-GO messages:

PITCH/ROLL FAIL

HDG or A.C. REF FAIL

SDCC PWR SUPPLY FAIL

SDCC CPU/MEMORY FAIL

SDCC WRAPAROUND FAIL

SDCC A/D FAIL

SDCC 1553 I/O FAIL

SDC FAIL

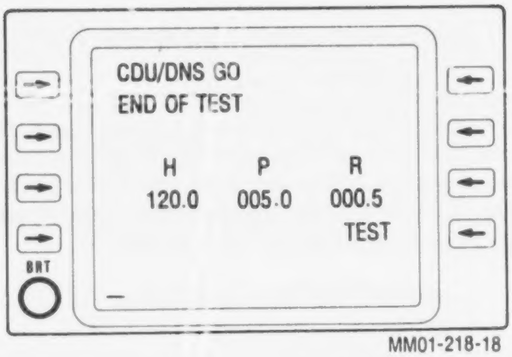
RTA FAIL

SDCC CMD FAIL

If no failures are detected, the CDU displays the FDLS page as shown in figure 3-7.13.

NOTE

The heading, pitch and roll values are calculated and displayed no more than five seconds after the GO message.



CDU/DNS GO
END OF TEST

H P R
120.0 005.0 000.5
TEST

MM01-218-18

Figure 3-7.13. FDLS Status Page - On Command Test Results GO.

(3) Press NAV FAB. Observe that the NAV top level present position page is displayed.

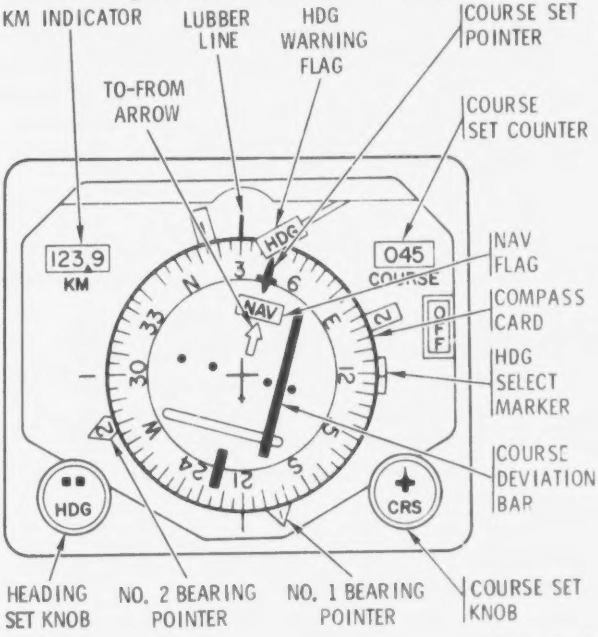
3-38.7. Stopping Procedure.

(1) Press ADMIN. Observe that the ADMIN page is displayed.

(2) Press PWR ON. Observe that PWR ON changes to PWR OFF.

3-39. HORIZONTAL SITUATION INDICATOR (HSI).

The HSI, on the pilot instrument panel is shown in figure 3-8. The HSI is an electromechanical indicator that presents position information in relation to various navigational inputs. The HSI interfaces with the heading and attitude reference set (HARS), the automatic direction finder (ADF), and the doppler navigation set. The instrument displays consist of a fixed aircraft symbol, a compass card, two bearing-to-station pointers with back-course markers, a course bar, a kilometer (KM) indicator, a heading set (HDG) knob and marker, a course set (CRS) knob, a COURSE digital readout, a to-from arrow, a NAV flag, and a compass HDG flag. Operating power for the HSI is taken from the 115 vac No. 1 essential bus through a circuit breaker marked HSI on the pilot center circuit breaker panel.


KM INDICATOR
LUBBER LINE
HDG WARNING FLAG
COURSE SET POINTER
TO-FROM ARROW
COURSE SET COUNTER
123.9
KM
HDG
045
COURSE
NAV
OFF
N
3
6
E
12
15
S
21
24
W
30
33
NAV FLAG
COMPASS CARD
HDG SELECT MARKER
COURSE DEVIATION BAR
HDG
CRS
HEADING SET KNOB
NO. 2 BEARING POINTER
NO. 1 BEARING POINTER
COURSE SET KNOB

MM01-036C

Figure 3-8. Horizontal Situation Indicator

3-40. Controls, Indicators, and Functions.

Controls and indicators for the horizontal situation indicator are as follows:

CONTROL/INDICATOR	FUNCTION
Compass Card	The compass card is a 360-degree scale that turns to display heading data obtained from the HARS. The aircraft headings are read at the upper lubber line.

CONTROL / INDICATOR	FUNCTION
Bearing pointer No. 1	The pointer operates in conjunction with the LDNS. It indicates relative bearing to the destination set in the FLY-TO-DEST thumbwheel. The No. 1 bearing pointer "parks" at the 3 o'clock position when the doppler "bearing-to-destination" signal is invalid.
Bearing pointer No. 2	This pointer operates in conjunction with the ADF receiver. The pointer is read against the compass card and indicates the magnetic bearing to the ADF station (nondirectional beacon).
Course deviation bar	This bar indicates the lateral deviation from a selected doppler course. When the helicopter is flying the selected doppler course, the course bar will be aligned with the course set pointer and will be centered on the fixed aircraft symbol.
CRS knob	Course set (CRS) knob and the course set counter operate in conjunction with the course pointer and allow the pilot to select any of 360 courses. Once set, the course pointer will turn with the compass card and will be centered on the upper lubber line when the helicopter is flying the selected course, providing there is no wind to blow the helicopter off course.
KM indicator	The digital distance display in kilometers (KM) to destination set on the doppler FLY-TO-DEST.
HDG knob	Heading set (HDG) knob operates in conjunction with the heading select marker and allows the pilot to select any one of 360 headings. Seven full turns of the knob produce a 360-degree turn of the marker.
To-from arrow	Works with VOR. Not applicable.
NAV flag	The NAV flag, on the HSI course carriage, turns with the compass card. The flag retracts from view when a reliable course deviation signal is available from the doppler.
HDG flag	The HDG flag (top of the indicator) retracts when a reliable heading signal is available from the HARS. During HARS alignment, retraction of the heading flag indicates that HARS is aligned (ready-to-fly).
Distance shutter	The distance shutter (upper left corner) retracts when the "distance-to-destination" signal from the doppler is valid.

3-41. TRANSPONDER AN/APX-100(V) 1 (IFF)

The transponder set (figure 3-9) provides automatic radar identification of the helicopter to all suitably equipped challenging aircraft as well as surface or ground facilities within the operating range of the system. AN/APX-100(V) receives, decodes, and responds to the characteristic interrogation of operational modes 1, 2, 3A, C, and 4. Specially coded identification of position (IP) and emergency signals may be transmitted to interrogating stations when conditions warrant. The transceiver can be operated in any one of four master modes, each of which may be selected by the operator at the control panel. Five coding modes are available to the operator. The first three modes may be used independently or in combination. Mode 1 provides 32 possible code combinations, any one of which may be selected in flight. Mode 2 provides 4096 possible code combinations, but only one is available and is normally preset before takeoff. Mode 3/A provides 4096 possible codes, any one of which may be selected in flight. Mode 4 is an external computer mode and can be selected to provide any one of many classified operational codes for security identification. Power to operate the IFF system is provided from the DC emergency bus through a circuit breaker marked IFF on the pilot overhead circuit breaker panel.

3-42. Antenna.

Two blade antennas (ref. figure 3-1) are used to receive interrogating signals and to transmit reply signals. The upper IFF antenna is installed on top of the fuselage area aft of the canopy, and the lower IFF antenna is installed on the bottom of the fuselage as an integral part of the UHF-AM antenna.

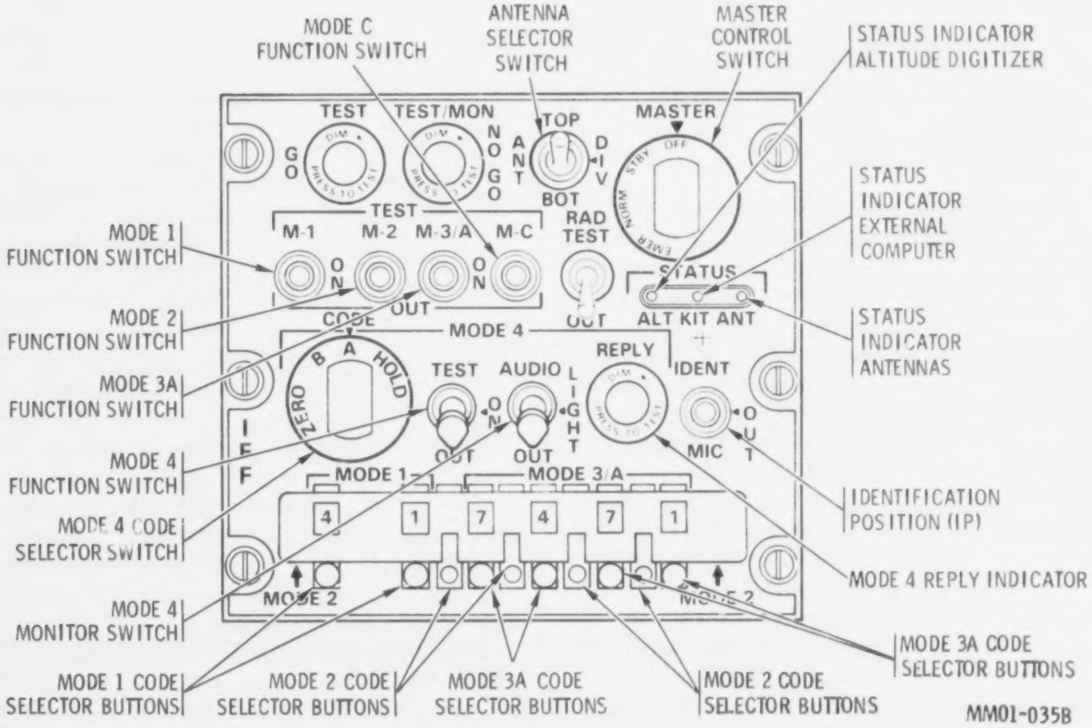

MODE C FUNCTION SWITCH
ANTENNA SELECTOR SWITCH
MASTER CONTROL SWITCH
STATUS INDICATOR ALTITUDE DIGITIZER
STATUS INDICATOR EXTERNAL COMPUTER
STATUS INDICATOR ANTENNAS
MODE 1 FUNCTION SWITCH
MODE 2 FUNCTION SWITCH
MODE 3A FUNCTION SWITCH
MODE 4 FUNCTION SWITCH
MODE 4 CODE SELECTOR SWITCH
MODE 4 MONITOR SWITCH
MODE 1 CODE SELECTOR BUTTONS
MODE 2 CODE SELECTOR BUTTONS
MODE 3A CODE SELECTOR BUTTONS
MODE 2 CODE SELECTOR BUTTONS
MODE 3A CODE SELECTOR BUTTONS
IDENTIFICATION POSITION (IP)
MODE 4 REPLY INDICATOR
TEST
GO
TEST/MON
NO GO
DIM
PRESS TO TEST
ANT
TOP
BOT
DIV
MASTER
OFF
STBY
NORM
EMER
TEST
M-1
M-2
M-3/A
M-C
ON
OUT
RAD TEST
STATUS
ALT KIT ANT
CODE
MODE 4
ZERO
B
A
HOLD
TEST
AUDIO
LIGHT
REPLY
IDENT
MIC
OUT
IFF
MODE 1
MODE 3/A
4
1
7
4
7
1
MODE 2
MODE 2
MM01-035B

Figure 3-9. Control Panel RT-1296 / APX-100(V)

3-43. Controls and Functions.

All operating and mode code select switches for transceiver operation are on Control Panel RT-1296/APX-100(V) (figure 3-9).

CONTROL / INDICATOR	FUNCTION
TEST GO	Indicates successful built-in-test (BIT).
TEST/MON NO GO	Indicates unit malfunction.
ANT	Selects antenna(s) to be used.
MASTER/OFF/STBY/ NORM/EMER	Selects operating condition.
M-1 TEST/ON/OUT	Determines whether Mode 1 is on, off, or in BIT operation.
M-2 TEST/ON/OUT	Determines whether Mode 2 is on, off, or in BIT operation.
M-3A/TEST/ON/OUT	Determines whether Mode 3A is on, off, or in BIT operation.
M-C TEST/ON/OUT	Determines whether Mode C is on, off, or in BIT operation.
RAD TEST/OUT	Enables TEST mode.
STATUS ALT	Indicates that BIT or MON failure is due to Altitude Digitizer.
STATUS KIT	Indicates that BIT or MON failure is due to external computer.
STATUS ANT	Indicates that BIT or MON failure is due to high voltage standing wave ratio (VSWR) in antenna.
MODE 4 CODE Selector	Selects condition of code changer in remote computer.
A.	Selects mode 4 code setting for present period.
B.	Selects mode 4 code setting for succeeding period.
HOLD	Retains mode 4 code setting when power is removed from transponder.
MODE 4 TEST/ON/OUT	Determines whether Mode 4 is on, off, or in BIT operation.
MODE 4 AUDIO/ LIGHT/OUT	Controls methods of monitoring Mode 4 operation.
MODE 4 REPLY	Indicates that a Mode 4 reply is generated.
IDENT/OUT/MIC	Controls transmission of I/P pulse.
MODE 1 Selector buttons	Selects Mode 1 code to be transmitted.
MODE 2 Selector buttons	Selects Mode 2 code to be transmitted.
MODE 3/A Selector buttons	Selects Mode 3/A code to be transmitted.

3-44. Operation.

a. **Starting Procedures.** If the MODE 2 code has not been set previously, loosen two screws which hold the MODE 2 numeral cover, and slide the cover upward to expose numerals of MODE 2 code switches (figure 3-9). Set these switches to code assigned to helicopter. Slide cover down and tighten screws.

(1) MASTER control switch – STBY.

(2) Allow 2 minutes for warmup.

(3) MODES 1 and/or 3A code selector buttons – Press and release until desired code shows.

(4) TEST, TEST / MON, and REPLY indicators – PRESS-TO-TEST. If Mode 1 is to be used, check as follows:

(5) M-1 switch – Hold at TEST; observe that no indicators are on.

(6) M-1 switch – Return to ON. If Modes 2, 3A, or M-C are to be used, check as follows:

(7) M-2, M-3/A, and M-C switches – Repeat steps 5 and 6.

NOTE

Do not make any checks: (1) near a radar site; (2) with MASTER control switch in EMER, or (3) with M-3A codes 7600 or 7700 - without first obtaining authorization from the interrogating stations.

(8) MASTER control switch – NORM. If Mode 4 is to be used, check as follows:

(a) MODE 4 CODE selector switch – position A.

(b) MODE 4 AUDIO / LIGHT OUT switch -- OUT.

(c) MODE 4 TEST / ON / OUT switch – Test: observe that TEST GO indicator lights and MODE 4 REPLY indicator do not light.

(d) MODE 4 TEST / ON / OUT switch – ON.

(9) ANT switch – BOT.

(10) Repeat steps 5 through 7, but observe that TEST GO indicator lights.

(11) ANT selector switch – TOP.

(12) Repeat step 5. through 7, but observe that TEST GO indicator lights.

(13) ANT selector switch – DIV.

(14) Repeat step 3 through 7, but observe that TEST GO indicator lights.

(15) When possible, request permission from interrogating station to activate radar test mode.

(a) RAD TEST switch – RAD TEST and hold.

(b) RAD TEST switch – Return to OUT.

(c) Verify from interrogating station that TEST MODE replay was received.

3-45. Normal Operation.

Completion of the starting procedure leaves the AN/APX-100(V) in operation. The following steps may be required, depending upon mission.

a. **Normal Mode.**

(1) MODE 4 CODE selector switch – A or B as required.

(a) If code retention in external computer is desired during transponder OFF mode, place MODE 4 CODE selector switch to HOLD and release. The MASTER control switch must be turned off within 15 seconds following placing MODE 4 CODE selection switch to HOLD.

(b) If code retention in external computer is not desired during transponder OFF mode, place MODE 4 CODE selector switch to ZERO to dump external computer code setting.

(2) Mode M-1, M-2, M-3/A, M-C, or MODE 4 switches – Select desired mode.

(3) Identification of position (I/P) Switch – IDENT, when required, to transmit identification of position pulses or set I/P switch to MIC to transmit I/P pulse only when microphone press-to-talk switch is actuated. (I/P pulses will be for 15 to 30-second duration when activated.)

b. **Emergency Mode.** During an emergency or distress condition, the AN/APX-100(V) may be used to transmit specially coded emergency signals on Mode 1, 2, 3/A, and 4 to all interrogating stations. Those emergency signals will be transmitted as long as the MASTER control switch on the control panel remains in EMER.

MASTER control switch - EMER.

c. **Stopping Procedure.** Refer to paragraph 3-45 (step a.) before stopping transponder.

MASTER switch - OFF.

3-46. Transponder Computer KIT-1A/TSEC.

The transponder computer operates in conjunction with Mode 4. A caution light on the pilot and CPG caution and warning panel, marked IFF, will go on when a malfunction occurs that will prevent a reply when interrogated in Mode 4 or the computer. Mode 4 operation is selected by placing the MODE 4 switch ON, provided the MASTER switch is at STBY or NORM. Placing the MODE 4 switch to OUT disables Mode 4. MODE 4 CODE switch is placarded ZERO, B, A, and HOLD. The switch must be lifted over a detent to switch to ZERO. It is spring-loaded to return from HOLD to the A position. Position A selects the Mode 4 code for the present code period, and position B selects the Mode 4 code for the succeeding period. Both codes are mechanically inserted by a code-changing key. The codes are mechanically held in the transponder computer, regardless of the position of the MASTER switch or the status of helicopter power, until the first time the helicopter becomes airborne. Thereafter, the Mode 4 codes will automatically zeroize any time the MASTER switch or helicopter power is turned off. The code setting can be mechanically retained. With weight on the landing gear, turn the CODE switch to HOLD (only momentary actuation is required) and release. The MASTER control switch must be turned OFF or helicopter power turned OFF within the 15 seconds immediately following placing MODE 4 CODE selector switch to HOLD. Mode 4 codes can be zeroized, any time the helicopter power is on and the MASTER switch is not in OFF, by turning the CODE switch to ZERO. Power to operate the transponder computer is automatically provided when the AN/APX-100(V) is on. The transponder computer KIT-1A/TSEC operation is classified.

3-47. ALTIMETER SET AN/APN-209(V).

The radar altimeter system (figure 3-10) provides instantaneous indication of actual terrain clearance height. Altitude, in feet, is displayed on a radar altimeter indicator on the instrument panel in front of the pilot. The radar altimeter indicator contains a pointer that indicates altitude on a linear scale from 0 to 200 feet (10 feet per unit) and on a second-linear scale from 200 to 1500 feet (100 feet per unit). An ON/OFF/LO altitude bug set knob, on the lower left corner of the indicator, combines functions to serve as low level warning bug set control and ON/OFF power switch. The system is turned on by turning the LO control knob, marked SET, clockwise from OFF. Continued clockwise turning of the control knob will permit the pilot to select any desired low-altitude limit as indicated by the LO altitude bug. Whenever the altitude pointer exceeds low-altitude set limit, the LO altitude warning light will go on. Turning the PUSH-TO-TEST HI SET control on the lower right corner of the indicator positions the high altitude bug. Whenever the pointer exceeds the HI altitude set limit, the high altitude warning light will come on. Pressing the PUSH-TO-TEST HI SET control provides a testing feature of the system at any time and altitude. When the PUSH-TO-TEST control knob is pressed, a reading between 900 feet and 1100 feet on the indicator and digital display will be displayed. The OFF flag removed from view indicates satisfactory system operation. Releasing the PUSH-TO-TEST SET control knob restores the system to normal operation. Loss of system power will be indicated by the indicator pointer moving behind the dial mask and the OFF flag reappearing in the center of the instrument. If the system should become unreliable, the flag will appear and the indicator point will go behind the dial mask to prevent the pilot from obtaining erroneous readings. Flight operations above 1500 feet do not require that the system be turned off. The pointer will go behind the dial mask but the transmitter will be operating. Power to operate the AN/APN-209 is supplied from the DC emergency bus through the circuit breaker marked RDR ALT on the pilot center circuit breaker panel.

3-48. Antennas.

The radar altimeter antennas (figure 3-1) are flush-mounted in a fairing on the bottom of the helicopter. The aft antenna is the transmitting antenna and the forward is the receiving antenna.

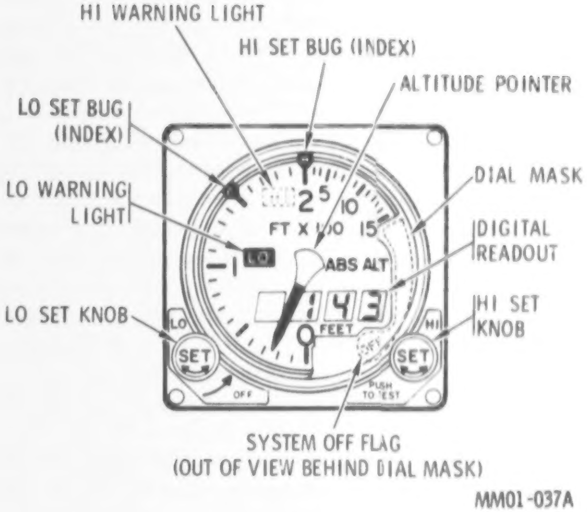

HI WARNING LIGHT
HI SET BUG (INDEX)
ALTITUDE POINTER
LO SET BUG (INDEX)
DIAL MASK
LO WARNING LIGHT
DIGITAL READOUT
LO SET KNOB
HI SET KNOB
2
5
10
15
FT X 100
ABS ALT
LO
HI
SET
SET
143
FEET
OFF
OFF
PUSH TO TEST
SYSTEM OFF FLAG (OUT OF VIEW BEHIND DIAL MASK)
MM01-037A

Figure 3-10. Altimeter Set AN/APN-209

3-49. Controls, Indicators, and Functions.

Control of the radar altimeter set is provided by the LO SET OFF knob on the front of the height indicator. The knob marked HI SET also controls the PUSH TO TEST (figure 3-10).

CONTROL/INDICATOR	FUNCTION
LO SET knob	Power control turned counterclockwise to OFF; clockwise to on.
LO SET bug	Sets altitude trip point of LO warning light.
HI SET bug	Sets altitude trip point of HI warning light.
HI SET knob	Pushing knob actuates built-in test system to self-test altimeter.
Altitude pointer	Provides an analog indication of absolute altitude from zero to 1500 feet.
Digital readout	Provides a direct-reading four-digit indication of absolute altitude from zero to 1500 feet.
LO warning light	Lights whenever dial pointer goes below L altitude bug setting.
HI warning light	Lights whenever dial pointer goes above H altitude bug setting.
OFF flag	Moves into view whenever altimeter loses track while power is applied.

3-50. Operation.

a. **Starting Procedure.**

(1) LO SET knob - On.

(2) LO set bug - Set to 80 feet.

(3) HI set bug - Set to 800 feet.

b. **Track Operation.** After about two minutes of warmup, the altimeter will go into track mode with these indications:

(1) OFF flag - not in view.

(2) Altitude pointer - 0 to +5 feet.

(3) Digital readout - 0 to +3 feet.

(4) LO warning light - will light.

(5) HI warning light - will be off.

c. **Self Test. Press and hold HI SET Knob.** The altimeter will indicate a track condition as follows:

(1) OFF flag - not in view.

(2) Altitude pointer - 1000 ± 100 feet.

(3) Digital readout - 1000 ± 100 feet.

(4) LO warning light - will be off.

(5) HI warning light - will light.

(6) HI SET knob - release. The altimeter will return to indications in step b, Track Operation.

3-51. Stopping Procedure.

LO SET knob - OFF.

3-52. HEADING AND ATTITUDE REFERENCE SYSTEM (HARS).

The Heading and Attitude Reference System (HARS) is a self-contained inertial platform which provides the pilot with helicopter attitude signals for pitch, roll, heading, velocities, and accelerations. The HARS control panel (figure 3-11) is located on the pilot lower right instrument panel. The control panel has a selector knob with four positions: OFF, OPR and two ALIGN positions FAST and NORM. Signals are sent to the MUX and to the doppler for use by the fire control computer and other systems such as DASE, navigation, stabilator, and symbology. The VDU (ref. figure 2-36) and the HDU (figure 4-2) display this information to the pilot. The HARS is powered from the No. 3 essential dc bus for 28 vdc and the No. 1 essential ac bus for 115 vac. The HARS circuits are protected by the HARS AC and HARS DC circuit breakers on the pilot overhead circuit breaker panel. HARS accomplishes internal bit and athermalization (for approximately 90 seconds) prior to initiating alinement. The status of the HARS is continuously monitored by the FD/LS; the on-command test (test 05 HARS) will fault isolate. The HARS may be alined using any one of four methods. The accuracy of the inertial platform alinement is dependent on the method chosen and the vibration environment during the alinement. The methods and accuracies are discussed below:

METHOD	HOW TO INITIATE	REQUIREMENTS	EFFECTS ON ACCURACY
Normal	sw to NORM	PP entered through data entry keyboard (DEK) prior to initiating alinement.	Best accuracy attained by permitting completion of HARS alinement prior to starting the engines. Some degradation to alinement accuracy will occur if the engines are started prior to the HARS completing the alinement. This degradation WILL NOT occur if one engine is started and the rotor speed established at 100% within one minute and forty-five seconds (1:45) after placing the HARS switch to NORM.
Stored Heading	sw to FAST	Helicopter shall not have been moved since HARS was shut down. PP entered through DEK prior to initiating alignment.	Uses data from previous HARS alinement and flight. Accuracy is dependent on that data. Alinement time is the shortest of all methods (approximately 90 to 120 seconds). Accuracy is not affected by engine starts.
FAST	sw to FAST	Same as normal alinement for PP.	Least accurate method. Fastest method when Stored Heading alinement is not possible.

METHOD	HOW TO INITIATE	REQUIREMENTS	EFFECTS ON ACCURACY
Inflight Restart	sw to OFF then to OPR	Doppler MAL light must be OFF. Recycle doppler if necessary.	If the HARS loses alinement in flight, the DASE will disengage. Switch the HARS OFF then to OPR; after approximately 90 seconds the heading flags will disappear and the DASE may be reengaged. The heading will appear to oscillate as the HARS attempts to aline. The heading accuracy should be within 3 degrees after five minutes. Navigation performance will be degraded significantly.

NOTE

If the helicopter is moved (heading or position) with the HARS switch in any of the aline positions, then the HARS shall be shut down and realined without moving the helicopter.

Inflight, the HARS continually gyrocompasses in order to maintain accuracy in North pointing. The biases and error estimates calculated during the gyrocompassing are stored as mission data memory by the HARS on shutdown. If, while flying, it becomes evident that the doppler navigation system has large unexplained errors, one of the possible causes of the doppler error may be that the stored mission data memory has become compromised. The mission data memory can be compromised through misuse or abuse of the HARS.

3-53. HARS Self Test.

NOTE

- Loss of the symbolic heading tape during the alinement phase of the HARS may indicate a problem with the mission data memory. Should this occur, proceed with a HARS self-test as follows:
- If the DEK is in the FD/LS position when the HARS alinement is initiated, the heading tape will not appear; return the DEK to STBY.
- This test should only be performed with the aircraft on the ground and APU power only.

1. HARS switch - OFF for 5-10 seconds.
2. PP entered thru DEK.
3. HARS switch - NORM for 5-10 seconds.
4. HARS switch - FAST wait for the HSI to show it's second rotation in heading (180 degrees from A/C heading). This should occur about 2-3 minutes after placing the switch to the FAST position.
5. During the rotation above, place the HARS switch back to NORM. The test will then execute.
6. If after 7-9 minutes the heading flag on the HSI is retracted and the symbol C heading tape is still displayed, the HARS has passed. Switch the HARS to OFF, reenter PP in the DEK and perform a normal alinement prior to moving the aircraft.
7. If the Hdg Flag remains in view, or if the symbolic heading tape is no longer visible, the self test has failed. Turn the HARS switch off and repeat steps 2 thru 6 above.
8. If the HARS passes the second test, the first failure was due to bad data in the mission data memory. Turn HARS OFF and complete a normal alinement prior to moving aircraft.
9. If the HARS fails the second test, the HARS unit is at fault; notify maintenance.

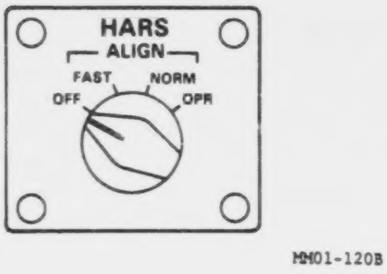


Figure 3-11. HARS Control Panel

3-53. Controls, Functions, and Operation.

Control	Function and Operation
OFF	Turns the HARS off.
FAST	Rapidly alines the HARS; least accurate on ground alinement method. Nominal time to aline: 4 to 6 minutes.
FAST	If the helicopter has not been moved following the previous shutdown of the HARS, a stored heading may be accomplished in this position. Nominal time to aline: 90 to 120 seconds.
NORM	Normal alignment of the HARS; most accurate when accomplished prior to engine start. Nominal time to aline 6 to 9 minutes.
OPR	Operating mode. Switch shall be in OPR prior to moving the helicopter.

NOTE

Whenever the helicopter is on the ground and will not be moved for greater than one minute, place the HARS switch in NORM. The HARS switch shall be placed in OPR prior to moving the helicopter.

best copy available

CHAPTER 4

MISSION EQUIPMENT

Section I. MISSION AVIONICS

4-1. MISSION AVIONICS – GENERAL.

The organization of this chapter has been divided into five major groups: Helicopter; Pilot; Copilot/Gunner (CPG); Fire Control System messages; and Armament.

4-2. HELICOPTER MISSION AVIONICS.

4-3. Air Data Sensor Subsystem (ADSS).

The air data sensor subsystem (ADSS) consists of an omni-directional airspeed sensor (OAS) and air data processor (ADP). The OAS (figure 2-1) measures the airspeed and temperature. The air data processor senses static pressure, and with the data from the OAS, calculates the air mass data required for fire control. The ADSS is interfaced with the multiplex bus through the DASE MRTU (figure 4-1). The ADSS is turned ON with the switch labeled ADSS on the AUX control panel in the CPG left console (figure 2-12). If the ADSS fails or is turned OFF, the displayed airspeed will revert to ground speed in knots as computed by the doppler navigation system. The ADSS receives 115 vac power from the No. 1 essential bus and 28 vdc from the No. 3 essential dc bus and is protected by the AIR DATA AC and AIR DATA DC circuit breakers on the pilot overhead circuit breaker panel. The status of the ADSS is continuously monitored by the Fault Detection/Location System (FD/LS); the on command test (test 01-ADS) will fault isolate to the specific line replaceable unit (LRU).

4-4. Backup Bus Controller (BBC).

The backup bus controller (BBC) is part of the CPG MRTU (figure 4-1). The BBC monitors the primary bus controller for faults during normal operations. The BBC automatically assumes control of the multiplex bus when it senses a failure of the fire control computer (FCC). The CPG can manually select the BBC as the primary bus controller by placing the MUX switch on the CPG fire control panel to the SEC position. When the BBC is the primary bus controller several fire control operational capabilities are not available. They are: Gun and Rocket ballistic solutions; Fault Detection/Location System; and Waypoint/Targeting. All other fire control capabilities are available and function identically as under FCC bus control. The BBC receives 28 vdc power from the No. 3 Essential DC bus and is protected by the MUX CPG circuit breaker located on the CPG circuit breaker panel. The status of the BBC is continuously monitored by FD/LS; the on command test (test 08-MUX) will fault isolate to the LRU.

4-5. Fire Control Computer (FCC).

The fire control computer (FCC) is the primary bus controller. The FCC controls all data transmissions on the multiplex bus during normal operations. The FCC processes and computes data for all fire control capabilities on board the helicopter (figure 4-1). The FCC continuously executes internal built-in-tests and in the event of a failure signals the BBC to assume control of the bus. The FCC, BBC and FAB MRTUs are turned ON with the switch labeled FCC/MUX ON (figure 4-15). Flight crew personnel shall ensure that this switch is in the ON position at all times during any ground or flight operations. The FCC receives 115 vac power from the No. 1 essential bus and 28 vdc power from the No. 3 essential dc bus and is protected by the FCC AC and FCC DC circuit breakers located on the CPG circuit breaker panel. To determine the FCC software code, place the **DEK** to **SP1** and enter C. The software code is displayed to the right of the dash.

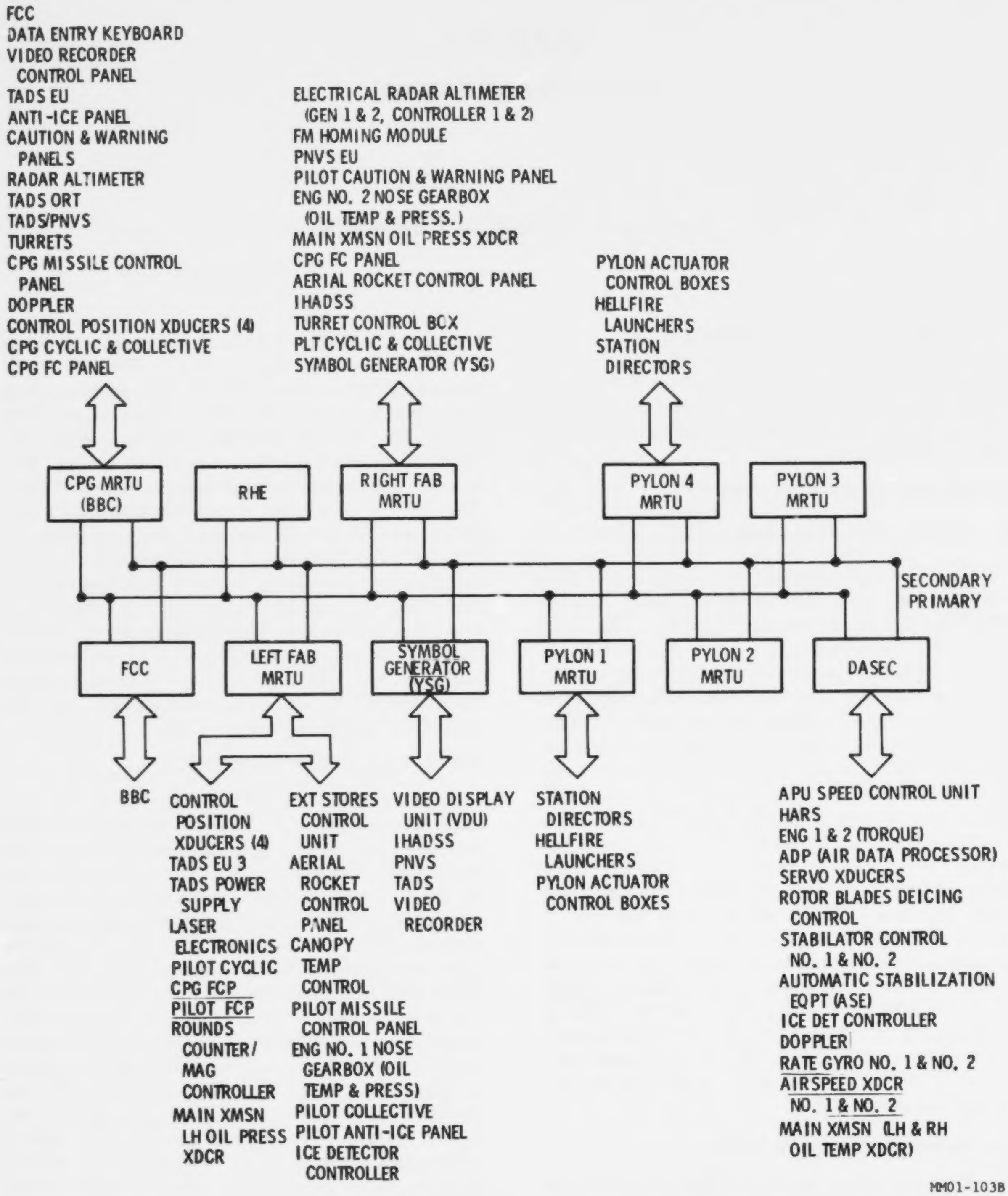

FCC
DATA ENTRY KEYBOARD
VIDEO RECORDER CONTROL PANEL
TADS EU
ANTI-ICE PANEL
CAUTION & WARNING PANELS
RADAR ALTIMETER
TADS ORT
TADS/PNVS
TURRETS
CPG MISSILE CONTROL PANEL
DOPPLER
CONTROL POSITION XDUCERS (4)
CPG CYCLIC & COLLECTIVE
CPG FC PANEL
ELECTRICAL RADAR ALTIMETER (GEN 1 & 2, CONTROLLER 1 & 2)
FM HOMING MODULE
PNVS EU
PILOT CAUTION & WARNING PANEL
ENG NO. 2 NOSE GEARBOX (OIL TEMP & PRESS.)
MAIN XMSN OIL PRESS XDCR
CPG FC PANEL
AERIAL ROCKET CONTROL PANEL
IHADSS
TURRET CONTROL BOX
PLT CYCLIC & COLLECTIVE
SYMBOL GENERATOR (YSG)
PYLON ACTUATOR CONTROL BOXES
HELLFIRE LAUNCHERS
STATION DIRECTORS
CPG MRTU (BBC)
RHE
RIGHT FAB MRTU
PYLON 4 MRTU
PYLON 3 MRTU
SECONDARY
PRIMARY
FCC
LEFT FAB MRTU
SYMBOL GENERATOR (YSG)
PYLON 1 MRTU
PYLON 2 MRTU
DASEC
BBC
CONTROL POSITION XDUCERS (4)
TADS EU 3
TADS POWER SUPPLY
LASER ELECTRONICS
PILOT CYCLIC
CPG FCP
PILOT FCP
ROUNDS COUNTER/ MAG CONTROLLER
MAIN XMSN LH OIL PRESS XDCR
EXT STORES CONTROL UNIT
AERIAL ROCKET CONTROL PANEL
CANOPY TEMP CONTROL
PILOT MISSILE CONTROL PANEL
ENG NO. 1 NOSE GEARBOX (OIL TEMP & PRESS)
PILOT COLLECTIVE
PILOT ANTI-ICE PANEL
ICE DETECTOR CONTROLLER
VIDEO DISPLAY UNIT (VDU)
IHADSS
PNVS
TADS
VIDEO RECORDER
STATION DIRECTORS
HELLFIRE LAUNCHERS
PYLON ACTUATOR CONTROL BOXES
APU SPEED CONTROL UNIT
HARS
ENG 1 & 2 (TORQUE)
ADP (AIR DATA PROCESSOR)
SERVO XDUCERS
ROTOR BLADES DEICING CONTROL
STABILATOR CONTROL NO. 1 & NO. 2
AUTOMATIC STABILIZATION EQPT (ASE)
ICE DET CONTROLLER
DOPPLER
RATE GYRO NO. 1 & NO. 2
AIRSPEED XDCR NO. 1 & NO. 2
MAIN XMSN (LH & RH OIL TEMP XDCR)
MM01-103B

Figure 4-1. Multiplex Bux (1553)

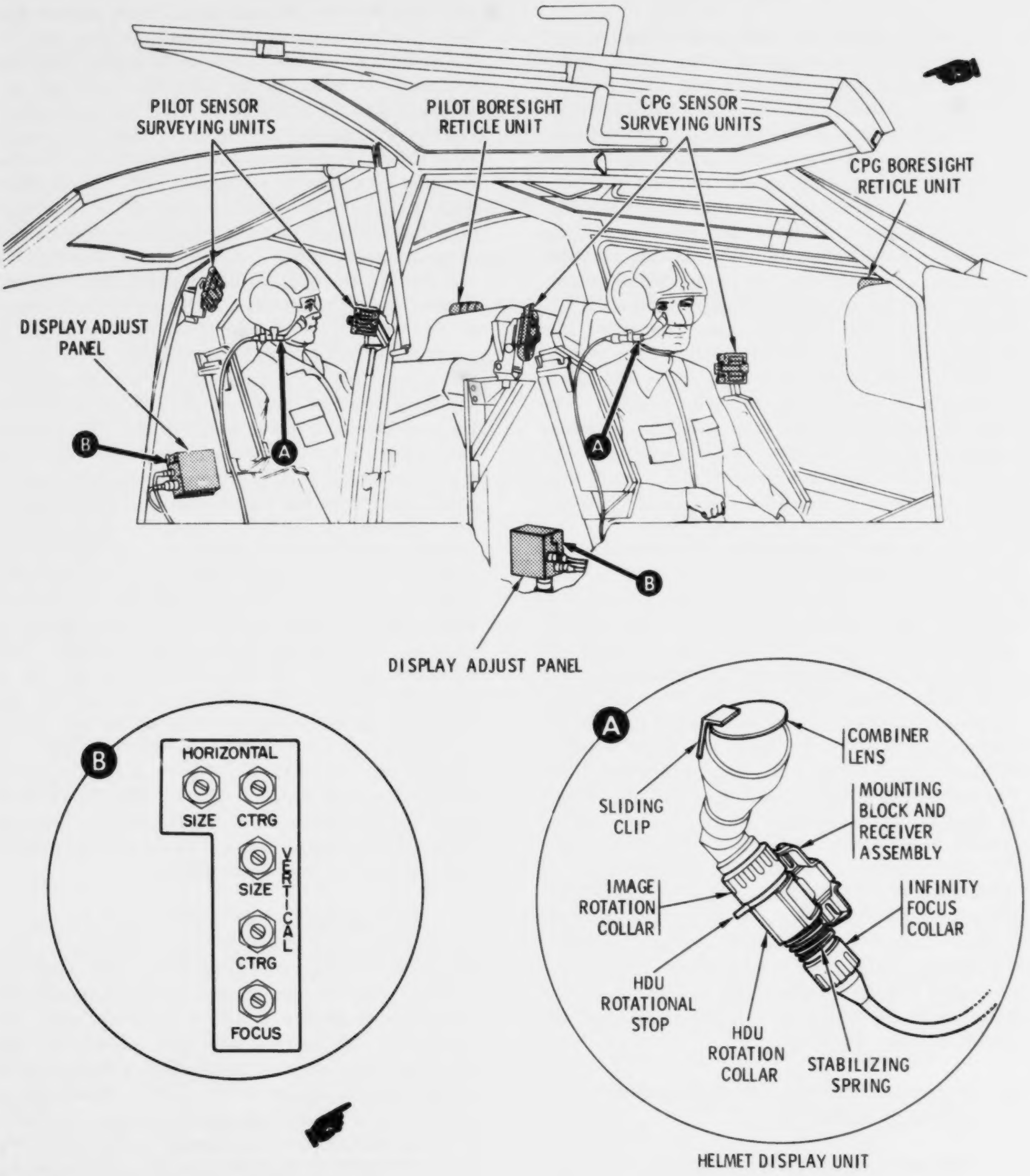
4-6. Multiplex Bus Subsystem (MUX).

The multiplex bus subsystem (figure 4-1) consists of multiplex remote terminal units (MRTU) and a redundant data bus. The MRTUs are used to interface the various subsystems onboard the helicopter. Three helicopter subsystems, the digital automatic stabilization equipment (DASE), the remote Hellfire electronics (RHE) unit, and the symbol generator also function as MRTUs. The RHE provides multiplex bus interface for the missile system electronics. The DASE provides multiplex bus interface for itself, ADSS, transmission and nose gearbox FD/LS, APU FD/LS, BUCS LVDTs, the external stores controller, and the heading attitude reference system. The symbol generator receives only data from the bus to use in generation of symbols on the video displays. The data bus consists of two identical bus networks separated down each side of the helicopter and interconnected in such a manner that loss of data communications is minimized or avoided in the event of battle damage. The multiplex bus system receives 115 vac power from the No. 1 essential bus and 28 vdc power from the No. 3 essential dc bus. The MRTUs are protected by their own circuit breakers: the DASE by the ASE AC and ASE DC circuit breakers located on the pilot overhead circuit breaker panel; the symbol generator by the SYM GEN circuit breaker located on the pilot overhead circuit breaker panel; the remote Hellfire electronics unit by the MSL DC ELEC circuit breaker located on the CPG circuit breaker panel. The remaining MRTU circuit breakers are located on the CPG circuit breaker panel and are labeled MUX L PYL OUTBD, MUX L PYL INBD, MUX R PYL OUTBD, MUX R PYL INBD, MUX FAB L and MUX FAB R. The status of the multiplex bus subsystem is continuously monitored by FD/LS; the on command test (test 08-MUX) will fault isolate to the specific LRU. The DASE, RHE and symbol generator MRTU functions are tested as part of each subsystem overall on command test (tests 02-DASE; 07-MSL; 13-SYMG).

4-7. Integrated Helmet and Display Sight Subsystem (IHADSS).

The integrated helmet and display sight subsystem (IHADSS) (Figure 4-2) consists of the crew member helmet; a helmet display unit (HDU), sensor survey units (SSU), a display adjust panel (DAP), and a boresight reticle unit (BRU) located in each crew station; and the sight electronics unit (SEU) and display electronics unit (DEU) located in the right forward avionics bay. Each helmet has two cable connections in the cockpit; they are: a TEMPEST ICS cable and a cable connecting the helmet electronics to the IHADSS. The sensor survey units, in conjunction with the sight electronics unit, determine the crew members line-of-sight (LOS). The weapons and sensor turrets can be directed by either crew member LOS. The helmet display unit (HDU) consists of a CRT with optical elements which project the selected symbology and sensor imagery onto a combining lens. The HDU is attached to the right side of the helmet during normal use. The attached HDU is rotated in front of the right eye for viewing of the display or can be rotated vertically away from the eye when not in immediate use. When not attached to the helmet the HDU shall be stored in the holster located on the right console inside kick panel. The display electronics unit provides power and video signals to each crew member HDU through the display adjust panel located in each crew station. The display adjust panel is used to adjust the image size, centering and electronic focus as it appears on the combining lens. These adjustments are normally required only after replacement of the DAP or HDU. The boresight reticle unit in each cockpit is used to boresight the crew member helmet. The IHADSS receives 115 vac power from the No. 1 essential bus and the SEU is protected by the IHADSS circuit breaker located on the pilot overhead circuit breaker panel; the DEU is protected by the IHADSS circuit breaker located on the CPG circuit breaker panel. The IHADSS is continuously monitored by FD/LS; the on command test (test 06-IHDS) will fault isolate to specific LRU including the crew member helmet.

a. **Operation**. Two actions shall be accomplished by each crew member each time the IHADSS is turned on. The HDU CRT shall be adjusted, and the crew member helmet boresighted. Adjustment of the HDU is accomplished by selecting the gray scale and adjusting the brightness and contrast to establish a displayed 10 shades of gray image on the HDU. Boresighting the helmet is accomplished by turning on the BRU, aligning the LOS reticle projected on the combining lens with the BRU alignment reticle, and actuating the BRSIT HMD switch. The requirement to boresight the IHADSS is announced to the crew member in the sight status block of the high action display and by the flashing of all four cueing dots on the symbology projected on the combining lens.


PILOT SENSOR SURVEYING UNITS
PILOT BORESIGHT RETICLE UNIT
CPG SENSOR SURVEYING UNITS
CPG BORESIGHT RETICLE UNIT
DISPLAY ADJUST PANEL
B
A
A
B
DISPLAY ADJUST PANEL
B
HORIZONTAL
SIZE
CTRG
SIZE
VERTICAL
CTRG
FOCUS
A
COMBINER LENS
SLIDING CLIP
MOUNTING BLOCK AND RECEIVER ASSEMBLY
IMAGE ROTATION COLLAR
INFINITY FOCUS COLLAR
HDU ROTATIONAL STOP
HDU ROTATION COLLAR
STABILIZING SPRING
HELMET DISPLAY UNIT

MM01-101C

Figure 4-2. Integrated Helmet and Display Sight System

The IHADSS can be boresighted in flight or on the ground. Display adjust panel adjustments are made usually following a maintenance action that replaced either the HDU or the DAP. The procedure requires assistance from the crew chief or fire control computer repairman. To accomplish: the crew member attaches the HDU to the helmet in the normal manner and rotates the HDU in front of his eye, the gray scale is selected and viewed, adjustments are first made for image centering so that the gray scale appears centered (HORIZONTAL CTRG, VERTICAL CTRG) (figure 4-2), next the gray scale size is adjusted so that the four borders of the image are just contained on the edges of the combining lens (HORIZONTAL SIZE, VERTICAL SIZE), and the corners are not visible, the last step is to adjust the electronic focus so that the gray scale image appears crisp and sharp (FOCUS).

4-8. External Stores Subsystem (ESS).

The external stores subsystem (ESS) consists of an external stores controller and up to four pylon assemblies. The external stores controller commands the pylons to the required elevation angles for the various fire control modes. The modes are: ground stow; flight stow; and FCC control. The ground stow mode articulates the pylons so that the wing stores are parallel with the ground over level terrain. The ground stow mode is automatically commanded on landing when the squat switch goes to ground mode, or in flight whenever the rocket select switch is placed in the GND STOW position. The GND STOW position would normally be selected immediately prior to landing on uneven terrain or when making a slope landing. The flight stow mode articulates the pylons to a single fixed position so that the wing stores present minimum flat plate drag area in forward flight. The flight stow mode is automatically commanded on takeoff whenever the squat switch goes air mode. The PLT/GND ORIDE switch will not override the squat switch for these functions. In flight, the pylons remain in the flight stow mode until missiles or rockets are actioned, which then places the pylons under FCC control. Under FCC control the pylons can be commanded through a range of +4.9 to -15 degrees. If the forward flight airspeed as sensed by the ADSS is 100 KTAS or greater, the pylons will remain in the flight stow position under FCC control and will not articulate. The external stores controller receives 115 vac power from the No. 1 essential bus and 28 vdc from the No. 2 essential dc bus. The external stores controller is monitored continuously by FD/LS; the on command test (test 10-PYLN) will fault isolate to the LRU.

a. **Pylon Assemblies**. The pylon assembly contains the pylon MRTU, the pylon aerial rocket control subsystem station director, the ejector rack, and the hydraulic actuator for articulation (figure 2-1). The pylon MRTU is used to interface the missile launcher and station director with the multiplex bus. The ejector rack contains the attaching lugs for the wing store, the winch assembly for lifting the wing store, and the ballistic ejector for stores jettison. The pylon assembly connects to electrical and hydraulic power when attached to the helicopter wing.

b. **Wing Stores Jettison**. Each pylon is equipped with an electrically operated ballistic ejector to jettison the attached wing store. Selectable wing stores jettison is activated by lifting the guard and pressing the spring loaded switch for the desired store (figure 2-11). An emergency stores jettison switch is located on each collective switchbox (figure 2-22) which when activated will jettison all wing stations simultaneously. The wings stores jettison receives 28 vdc power from the No. 2 essential dc bus and the emergency dc bus; the selectable stores jettison circuit is protected by the MISSION JETT circuit breaker on the pilot overhead circuit breaker panel; the emergency stores jettison circuit is protected by the JETT circuit breaker on the pilot overhead circuit breaker panel. The two stores jettison circuits are completely independent.

4-9. Symbol Generator. The symbol generator receives data from the bus controller and creates the symbols on the video image. The symbol generator also serves as the video switching unit for the helicopter. The symbol generator receives incoming video from the TADS, PNVS and video recorder and routes them to crew stations as requested by the crew members. The symbol generator will display video and symbology or symbology only on any of the displays: IHADSS, TADS ORT, or VDU. In the event of a symbol generator failure the IHADSS DEU will display the PNVS FLIR 2 video images without symbology on both the pilot and CPG HDUs. The TADS FLIR 2 video image will be displayed on the TADS ORT. The only symbology on the TADS FLIR 2 will be the TADS reticle and the IAT tracking gates when the IAT is engaged. The pilot VDU will not have an image for display. The symbol generator receives 115 vac power from the No. 1 Essential Bus and is protected by the SYM GEN circuit breaker on the pilot overhead circuit breaker panel. The symbol generator is continuously monitored by FD/LS; the on command test (test 13-SYMG) will fault isolate to the LRU.

4-10. Cyclic and Collective Mission Equipment Switches. The cyclic and collective have several switches used for the mission equipment (figure 2-22).

a. **Description of Cyclic Switches.**

CONTROL/ SWITCH	POSITION	FUNCTION
Weapon Action Switch (WAS)		A five position momentary switch which actions the selected weapon and removes the electrical trigger interlock. The actioned weapon may be deselected by re-actioning the same weapon or by selecting another weapon.
	G	Actions the 30mm Gun (12:00 position on the WAS).
	R	Actions the Aerial Rocket system (9:00 position on the WAS).
	M	Actions the Hellfire missile system (3:00 position on the WAS).
	C	Fires the chaff, if Chaff system armed (6:00 position on the WAS).
Flight Symbology Mode Switch		A three position momentary switch which permits the selection of the different flight symbology modes. Cruise and Transition, alternately, in the forward position and Hover and Bob-up in the aft position.
Trigger		A two position guarded trigger which enables weapons firing. The first detent is for normal selected weapons usage; the second will override the selected weapons performance inhibits but not the safety inhibits of the selected weapon.

b. **Description of Collective Switches.**

CONTROL/ SWITCH	POSITION	FUNCTION
RF OVRD		Immediately modes the missile system for an RF/IR missile.
NVS		This two position switch is not active unless the crew member has selected the NVS position on the sight select switch on the fire control panel.
	PNVS	Pilot: Selects the PNVS as the sensor to be used by the pilot. PNVS video with flight symbology will be displayed on the pilot HMD. CPG: If the PLT/GND ORIDE switch is OFF, the position is inactive. If the PLT/GND ORIDE switch is in ORIDE, this position allows takeover of control of the PNVS from the pilot and coupling it to the CPG helmet LOS. PNVS video with flight

CONTROL/ SWITCH	POSITION	FUNCTION
NVS (cont)	PNVS (cont)	symbology will be displayed on the CPG HMD.
	TADS	Pilot: Permits the pilot to take control of the TADS from the CPG and automatically place the TADS in WFOV FLIR with flight symbology. This would be done in the event of a PNVS failure and is the PNVS backup mode.
	TADS	CPG: Automatically modes the TADS for WFOV FLIR with flight symbology and couples the TADS to the CPG helmet LOS. This mode is accomplished independent of the PNVS and would be used by the CPG or IP to provide separate monitor for obstacle or terrain avoidance.
PLRT/BRSIT HMD	PLRT	Alternates the FLIR polarity back and forth; black hot or white hot.
	BRSIT HMD	Activates the IHADSS sight electronics unit to compute the boresight bias.

4-11. PILOT CONTROL PANELS.

4-12. Aerial Rocket Control Subsystem Panel (ARCS). The aerial rocket control subsystem (ARCS) is located in the pilot left console (figure 2-11). The ARCS receives power from the No. 3 essential dc bus and is protected by the RKT ELEX circuit breaker on the pilot overhead circuit breaker panel. The ARCS is continuously monitored by FD/LS; the on command test (test 11-RKT) will fault isolate to the LRU. The function of each control (figure 4-3) is as follows:

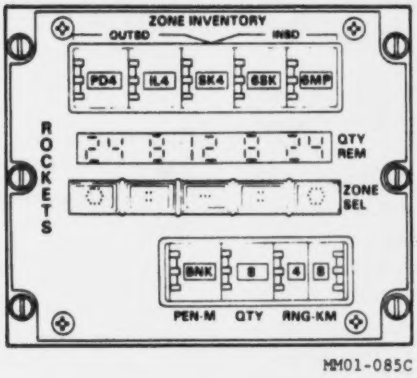


Figure 4-3. Aerial Rocket Control Panel

CONTROL/ INDICATOR	SWITCH	FUNCTION
Zone Inventory		Indicates the type of 2.75 FFAR round loaded in the zone.
	PD4	High explosive warhead with PD fuzing with a MK 40 motor.
	RC4	High explosive warhead with remote set fuzing with a MK 40 motor.
	DP4	High explosive dual purpose warhead with PD fuzing with a MK 40 motor.

CONTROL/ INDICATOR	SWITCH	FUNCTION
	WP4	White phosphorus warhead with PD fuzing with a MK 40 motor.
	IL4	Illumination warhead with remote set fuzing with a MK 40 motor.
	SK4	Smoke warhead with remote set fuzing with a MK 40 motor.
	6PD	High explosive warhead with PD fuzing with a MK 66 motor.
	6RC	High explosive warhead with remote set fuzing with a MK 66 motor.
	6IL	Illumination warhead with remote set fuzing with a MK 66 motor.
	6SK	Smoke warhead with remote set fuzing with a MK 66 motor.
	6MP	Multi-purpose submunitions warhead with remote set fuzing with a MK 66 motor.
	Blank	Not implemented.
RNDS REM		Indicates the functional rounds remaining in inventory by zone location.
ZONE SEL		Pressing the appropriate ZONE SEL switch arms the selected zone. When any one zone is selected all other zones displaying the same zone inventory will be automatically armed and visually indicated by
ZONE SEL (cont)		illumination of the appropriate ZONE SEL switches. Any currently selected (armed) zones which are different from the ZONE SEL switch pressed will automatically be de-selected (de-armed).
PEN-M		Permits the pilot to select tree height of burst detonation (5 meter increments), superquick detonation, or bunker penetration prior to detonation.
	45	
	40	
	35	Canopy height in meters
	30	
	25	Enables rocket to penetrate canopy of foliage or building and detonate at a more effective point.
	20	
	15	
	10	
	5	
	BNK	Bunker penetration – To defeat bunkers (logs and dirt) up to 3 meters thick.
	SQ	Superquick – detonates when fuze makes contact with any object.
QTY		Selects the quantity of rockets to be fired.
	ALL	Sustained or continuous fire of all rockets in zones selected.
	12	12 rockets to be fired
	8	8 rockets to be fired
	4	4 rockets to be fired
	2	2 rockets to be fired
	1	1 rocket to be fired
RNG-KM		

NOTE

The RNG-KM thumbwheel selectors on the rocket control panel are the pilot manual range entry for ALL armament the pilot may select. Automatic range calculations are based on the pilot LOS and radar altitude; a flat earth model.

CONTROL/ INDICATOR	SWITCH	FUNCTION
		Left Thumbwheel selector
	Numerals	Selects multiples of 1000 meters.
	A	Signals for automatic range calculation to be executed. During rocket engagements time to function fuzing data is passed by the FCC to the ARCS.
		Right Thumbwheel selector
	Numerals	Selects multiples of 100 meters.

4-13. Pilot Missile Control Panel. The pilot missile control panel is located in the pilot left console (figure 2-11). The function of each control, (figure 4-4) is as follows:

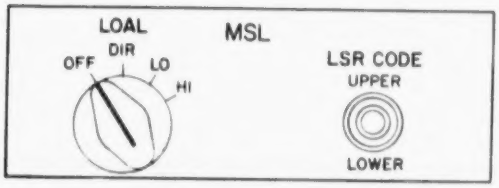


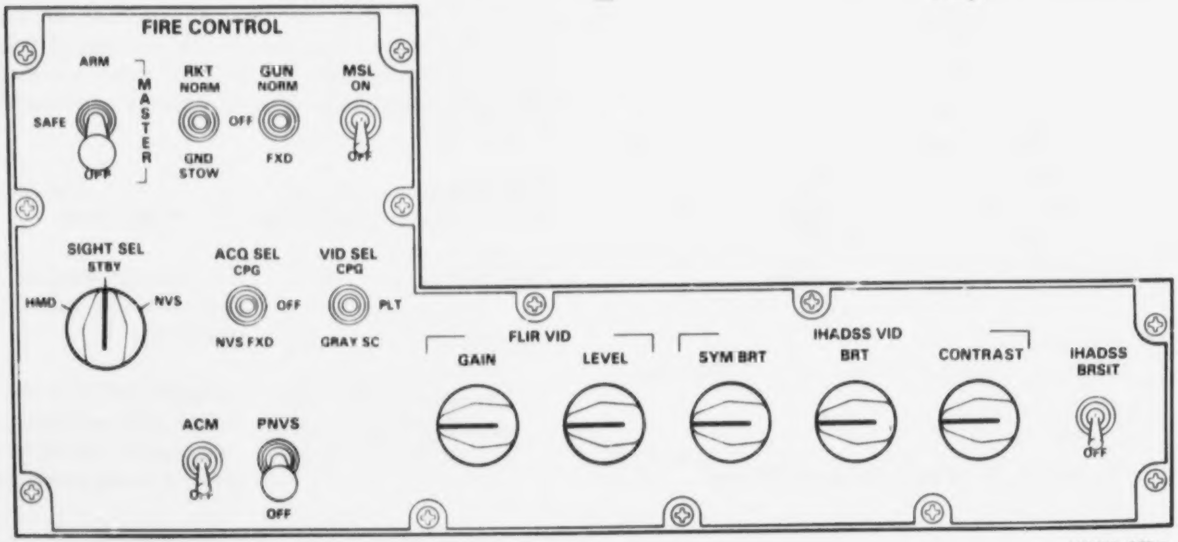
Figure 4-4. Pilot Missile Control Panel

CONTROL/ INDICATOR	POSITION	FUNCTION
LOAL	OFF	Disables Lock-On-After-Launch mode and defaults to Lock-On-Before-Launch (LOBL) missile launch mode.
	DIR	Direct fire LOAL launch trajectory.
	LO, HI	Indirect fire LOAL launch trajectories.
LSR CODE		This is the CHAN SEL switch and used to command the missile subsystem to accept and validate the mode, code and quantity of missiles selected. The selection of UPPER or LOWER tells the missiles subsytem which coded missiles to establish as the priority channel, by default, the other coded missiles are the alternate channel.

4-14. Pilot Fire Control Panel. The pilot fire control panel (figure 4-5) is located in the lower left quadrant of the pilot vertical instrument panel (figure 2-9) and receives power from the No. 1 essential bus and the No. 3 essential dc bus; protection is provided by the FC AC and FC DC cricuit breakers located on the pilot overhead circuit breaker panel. The function of each control is as follows:

CONTROL/ INDICATOR	POSITION	FUNCTION
MASTER	OFF	Disables all weapon control and power to weapons.
	SAFE	Enables SAFE power to the pilot weapons select switches and provides safe power to

CONTROL/ INDICATOR	POSITION	FUNCTION
MASTER (cont)	SAFE	the CPG ARM switch. A green SAFE light indicates a valid safe condition.
	ARM	Enables ARM power to all weapon firing circuits and provides ARM power to the CPG ARM switch. An amber ARM light indicates a valid arm condition.
RKT	OFF	Disables SAFE/ARM power to the Aerial Rocket Control Subsystem (ARCS).
	NRML	Enables pilot SAFE/ ARM power to the ARCS and permits pylon articulation during pilot initiated rocket firing.
	GND STOW	Places the wing stores in the ground stow position; parallel with the ground on level terrain.
GUN	OFF	Disables pilot SAFE/ ARM power to the M-230E1, 30mm gun subsystem.
	NRML	Enables pilot SAFE/ ARM power to the gun subsystem and permits slaving of the gun turret to the pilot LOS when actioned.
	FXD	Enables pilot SAFE/ ARM power to the gun subsystem and permits positioning of the gun turret to the fixed forward position when actioned.
MSL	OFF	Disables pilot SAFE/ ARM power to the Hellfire missile subsystem.
	ON	Enables pilot SAFE/ ARM power to the Hellfire missile subsystem
SIGHT SEL	STBY	Deselects all lines-of-sight and stows sensor turret. IHADSS LOS active for boresight only.


FIRE CONTROL
ARM
SAFE
OFF
MASTER
RKT NORM
GND STOW
OFF
GUN NORM
FXD
MSL ON
OFF
SIGHT SEL
STBY
HMD
NVS
ACQ SEL
CPG
OFF
NVS FXD
VID SEL
CPG
PLT
GRAY SC
FLIR VID
GAIN
LEVEL
SYM BRT
IHADSS VID
BRT
CONTRAST
IHADSS BRSIT
OFF
ACM
OFF
PNVS
OFF

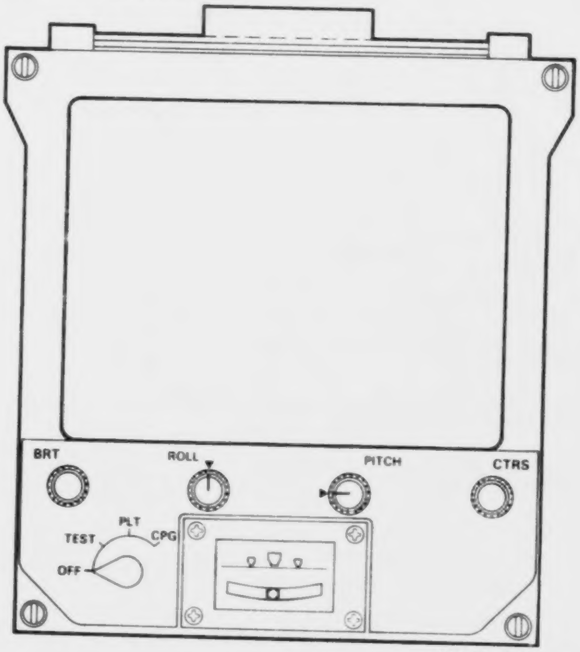
MM01-081C

Figure 4-5. Pilot Fire Control Panel

CONTROL/ INDICATOR	POSITION	FUNCTION
	HMD	Selects the helmet mounted display (HMD) as the pilot reference LOS and activates the display electronics for display of flight symbology.
	NVS	Activates the NVS select switch on the collective switchbox for sensor selection. The HDU will display the selected night vision sensor FLIR video with flight symbology.
ACQ SEL	OFF	No cueing symbology displayed to the pilot.
	CPG	Pilot receives cueing symbology to the CPG selected sight LOS.
	NVS FXD	If the pilot has selected an NVS sensor, the sensor turret will be slaved to the fixed forward position.
VID SEL	CPG	Permits the pilot to observe the CPG selected video on his HMD.
	PLT	Permits the pilot to observe his selected sensor video and symbology on the HMD.
	GRAY SC	Displays to the pilot on his HMD a 10 shades of gray scale. To be used in calibration of the HMD brightness and constrast.

CONTROL/ INDICATOR	POSITION	FUNCTION
ACM		Auto Control Module. The switch is used to maintain an optimum gain and level setting of the selected night vision sensor during varying thermal scene content or when switching FLIR polarity.
PNVS	OFF	Disables all power to the pilot night vision sensor.
	ON	Enables power to the pilot night vision sensor and begins cool down of the FLIR.
FLIR VID	GAIN	A rheostat adjustment varying the thermal image gain, analogous to display contrast.
	LEVEL	A rheostat adjustment varying the thermal image level, analogous to display brightness.
IHADSS VID	SYM BRT	A rheostat adjustment varying symbol brightness from bright white to black.
	BRT	A rheostat adjustment varying image brightness on the IHADSS HDU. Used for initially setting brightness with the gray scale.
	CONTRAST	A rheostat adjutment varying image contrast on the IHADSS HDU. Used for initially setting contrast with the gray scale.
IHADSS BRSIT		Enables power to the boresight reticle unit and places the pilot IHADSS in boresight mode.
	OFF	Disables power to the boresight reticle unit.

4-15. Video Display Unit. The video display is located in the pilot vertical instrument panel (figure 2-9). The basic configuration VDU has a red night filter which is stored in a bracket on top of the VDU. The -3 configuration VDU has a gray night filter which is stored in a protective pouch on top of the VDU. The red and gray filters are used on evening and night flights to provide a display which does not affect the pilots night vision. The VDU has the capability of displaying the video from either the pilot or CPG selected sensors independent of the IHADSS. This permits the pilot to have a simultaneous display of the PNVS video on the HMD and CPG video on the VDU. In the event of pilot HDU failure, a limited night terrain flight capability is available by selecting PLT video on the VDU and placing the PNVS in the NVS FXD position. The VDU (figure 4-6) receives 28 vdc power from the No.2 essential dc bus and is protected by the VDU circuit breaker located on the pilot overhead circuit breaker panel. The VDU is not monitored by FD/ LS. The function of each switch is as follows:



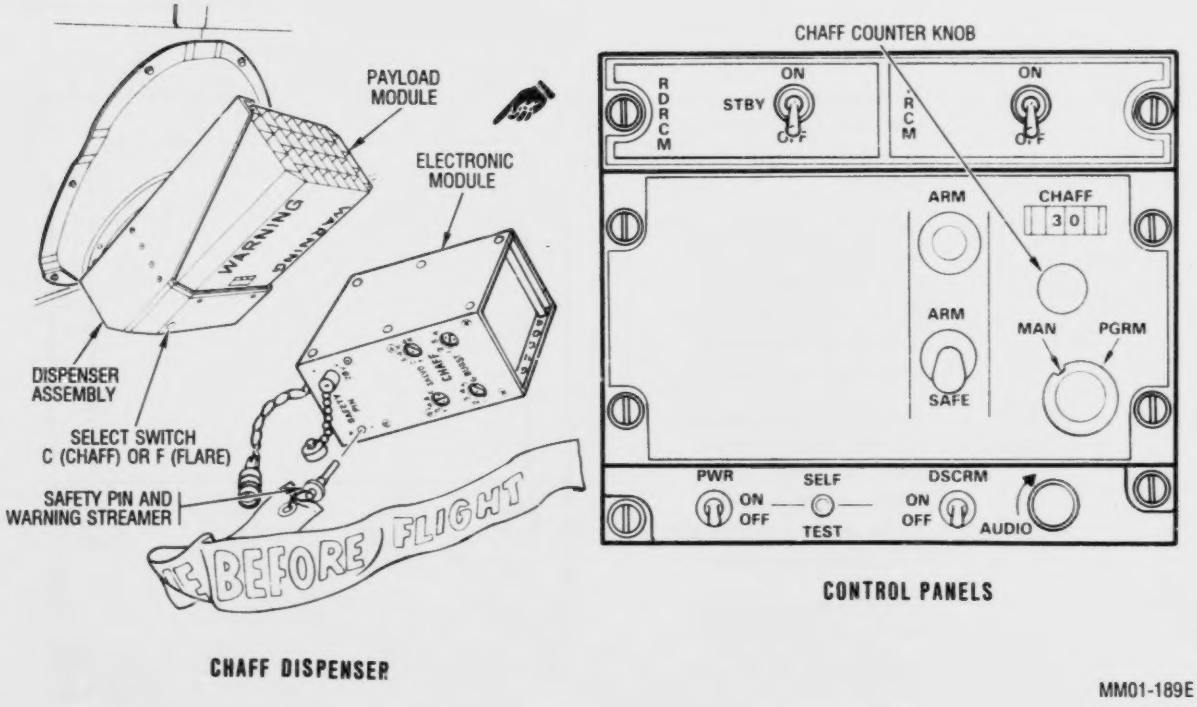
MM01-023C

Figure 4-6. Video Display Unit

POSITION	FUNCTION
OFF	Disables all power to the VDU
TEST	Displays on the CRT a vertically oriented test pattern.
PLT	Displays pilot's selected video.
CPG	Displays CPG selected video.
BRT	Adjusts display brightness
CTRS	Adjusts display contrast in PLT/CPG mode.
ROLL	Adjusts roll trim on the symbolic horizon displayed in the transition and cruise modes of flight symbology.
PITCH	Adjusts the pitch trim on the symbolic horizon displayed in the transition and cruise modes of flight symbology.

4-16. DISPENSER KIT M-130 (REF. TM 9-1095-206-13&P).

The general purpose dispenser M-130 (figure 4-7) consists of a single subsystem (dispenser assembly, payload module assembly, electronics module and dispenser control panel) designed to dispense M-1 Chaff. The subsystem provides effective survival countermeasures against radar guided weapons systems. The dispenser subsystem, M-130, has the capability of dispensing 30 chaff cartridges. Power to operate the chaff is provided from the No. 2 essential dc bus and is protected by the PEN AIDS CONTR circuit breaker located on the pilot overhead circuit breaker panel. The control panel is located on the right vertical instrument panel (figure 2-9). The dispenser kit is not monitored by FD/LS.


PAYLOAD MODULE
ELECTRONIC MODULE
WARNING
DISPENSER ASSEMBLY
SELECT SWITCH C (CHAFF) OR F (FLARE)
SAFETY PIN AND WARNING STREAMER
BEFORE FLIGHT
CHAFF COUNTER KNOB
RDRCM
ON
STBY
OFF
RCM
ON
OFF
ARM
CHAFF
30
ARM
SAFE
MAN
PGRM
PWR
ON
OFF
SELF
TEST
DSCRM
ON
OFF
AUDIO
MM01-189E

CONTROL PANELS

CHAFF DISPENSER

Figure 4-7. Countermeasures Panel

CONTROL/ INDICATOR	POSITION	FUNCTION
CHAFF counter		Displays the number of chaff cartridges remaining in the payload module.
CHAFF counter knob		Adjusts counter to correspond to number of chaff cartridges loaded in payload module.
ARM light		Indicates that the arming switch is at ARM, safety flag pin removed, and payload module is armed.
ARM/SAFE switch	ARM	Applies electrical power through safety flag switch to cycle WAS for firing.
	SAFE	Removes power from dispenser subsystem.
MODE selector		Selects type of chaff release.
	OFF	Removes power from dispenser subsystem.
	MAN	Dispenses one chaff cartridge each time the WAS chaff fire position is toggled.
	PRGM	Dispenses chaff according to predetermined bursts per salvo and number of salvos, automatically.

a. **Dispenser Assembly**. The dispenser assembly (figure 4-7) contains the breech assembly, C-F selector switch, a reset switch, and a housing containing the sequencer assembly. The sequencer assembly receives power through the firing switch circuit and furnishes pulses to each of the 30 contacts of the breech assembly, in sequential order 1 through 30, thus firing each of the impulse cartridges. This assembly contains a safety pin and warning streamer. A remote safety pin is provided on the tailboom just forward of the dispenser assembly.

b. **Payload Module Assembly**. The payload module assembly (figure 4-7) consists of the payload module and retaining plate assembly. The payload module has 30 chambers which will accept chaff. The chaff cartridges are loaded through the studded end of the module, one per chamber, and are held in place by the retaining assembly. The payload module assembly is assembled into the dispenser assembly.

c. **Electronic Module Assembly**. The electronic module assembly contains a programmer and a cable assembly which includes a 28 volt supply receptacle and a safety switch which is actuated by inserting the safety pin with streamer. The programmer consists of a programming circuit which allows the setting of chaff burst quantity, burst interval, salvo quantity, and salvo interval. The electronics module is located in the right aft avionics bay.

4-17. Dispenser Electronic Module Controls. The controls on the electronics module (figure 4-7) are used to program the chaff dispenser for predetermined release of chaff cartridges. The function of each control is as follows:

CONTROL	FUNCTION
SAFETY PIN	Safety switch to accept the safety pin with streamer, placing the dispenser in a safe condition when the helicopter is on the ground.
SALVO COUNT	Programs the number of salvos: 1, 2, 4, 8, or C (continuous). A salvo is the same as one burst.
SALVO INTERVAL	Programs the time in seconds between salvos: 1, 2, 3, 4, 5, 8, or R (random 2, 5, 3, 4, 3).

CONTROL	FUNCTION
BURST COUNT	Programs the number of chaff cartridges that are fired in one burst: 1, 2, 3, 4, 6, or 8.
BURST INTERVAL	Programs the time interval in tenths of a second between individual chaff cartridge firings within a burst: 0.1, 0.2, 0.3, or 0.4.

4-18. Dispenser Kit Safety Procedures. The following special safety procedures shall be followed:

a. Chaff and impulse cartridges shall be kept away from all fires and excessively high temperatures.

b. Impulse cartridges must be handled with extreme care. Each cartridge generates extremely high gas pressure and temperature when fired.

c. The safety pin shall be installed in the safety switch or remote location whenever the helicopter is parked. Safety pin is removed prior to takeoff.

d. Avoid exposure to high concentrations of chaff; can cause temporary irritation to eyes and throat.

4-19. Dispenser Kit Operation.

CAUTION

Operation is totally independent of aircraft ARM/SAFE power.

1. Chaff counter – Set for number of chaff cartridges in payload module.
2. Mode switch – MAN.

NOTE

Mode switch should always be in the MAN position prior to moving the SAFE/ARM switch to ARM to prevent immediate salvo of chaff.

3. SAFE/ARM switch – ARM; ARM indicator light on.
4. Cyclic Weapon Action Switch – Chaff (6:00 position) as desired to fire chaff.
5. Stopping Procedure – SAFE/ARM switch – SAFE.

4-20. RADAR SIGNAL DETECTOR SET AN/APR-39V-1.

The operating controls of the AN/APR-39V-1 panel (figure 4-7) are as follows:

CONTROL	POSITION	FUNCTION
PWR	ON	Turns set on. Fully operational after 1-minute warmup.
	OFF	Turns set off.
DSCRM		Selects mode of operation.
	ON	Activates discriminator circuit.
	OFF	Deactivates discriminator circuit.
SELF-TEST		When pressed, initiates self-test confidence check (except for antenna and receiver).
AUDIO		Adjusts volume to the intercommunications system.
DIRECTION DISPLAY (CRT display)		Displays a line-of-bearing radial strobe for each processed emitter signal.
MA Indicator		Missile Alert. Flashes on and off to indicate time correlation between missile guidance and associated tracking radar.
BRIL Control		Adjusts CRT display brightness.
Filter Control		Varies density of red polarized CRT faceplate filter (used for day or night operation) by moving tang right or left.

4-21. Operation (AN/APR-39V-1). The radar signal detector AN/APR-39V-1 may be operated in either the discriminator off or discriminator on modes. The radar signal detector set receives power from the No. 2 essential dc bus and is protected by the PEN AIDS CONT circuit breaker located on the pilot overhead circuit breaker panel. The radar signal detector set is not monitored by FD/LS.

NOTE

Display strobe lengths indicate only relative signal amplitude. Since many variables can affect the atmospheric attenuation of the signals, strobe length should not be considered as a direct interpretation of the distance to the emitter.

a. **Discriminator Off Mode**. When operating in the discriminator off mode, the DSCRM switch is placed OFF. In this mode all high band received signals with amplitude greater than a predetermined threshold level are displayed on the CRT and an audio signal, representative of the combined amplitudes and pulse repetition frequencies (PRF), is presented at the headset. The displays indicate the total radar environment in which the helicopter is operating. Each radial strobe on the CRT is a line of bearing to an active emitter. When a SAM radar complex becomes a threat to the helicopter (low band signals correlated with high band signals), the unique alarm audio is superimposed on the PRF audio signal and the MA light and associated strobe start flashing. Lengths of strobes and audio levels depend on the relative strength of the intercepted signals. A typical display when operating in the discriminator off mode is shown in figure 4-8.

NOTE

In this mode, received low band signals which are not correlated with a high band intercept will cause the MA light to flash and an alarm audio will be present.

b. **Discriminator On Mode**. When operating in the discriminator on mode, the DSCRM switch is placed ON. In this mode, signals are processed to determine their conformance to certain threat associated criteria.

(1) The signal level must be greater than the minimum threshold level.

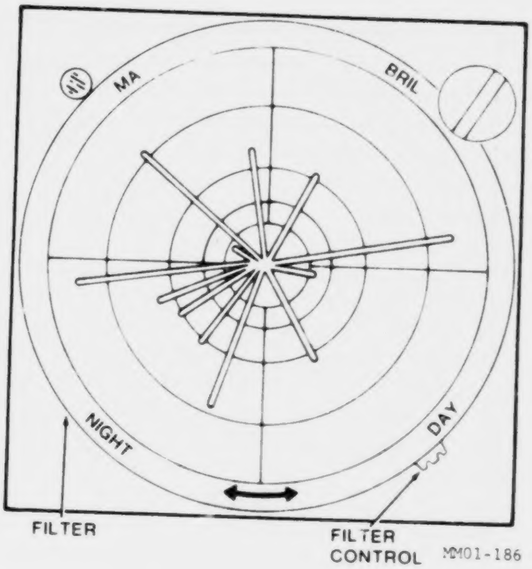


Figure 4-8. Discriminator Off Mode Display

(2) Pulse width must be less than the maximum pulse width.

(3) PRF must be greater than the minimum pulses per second.

(4) The pulse train must exist with not less than the minimum pulse train persistance.

(5) The CRT display is divided up into eight sectors. Strobes are displayed only in those sectors in which signals meeting all threat criteria are present. This reduces display clutter by eliminating low-level and wide pulse width signals and by selective sector display. Intercepts which meet these requirements are displayed as described in (a) above.

NOTE

In this mode, uncorrelated low band signals wil not give any indications.

(6) A typical display when operating in the discriminator ON mode is shown in figure 4-9. Conditions are the same as for figure 4-8, but is assumed that one or more threats have been identified in the 225 to 270 degree sector.

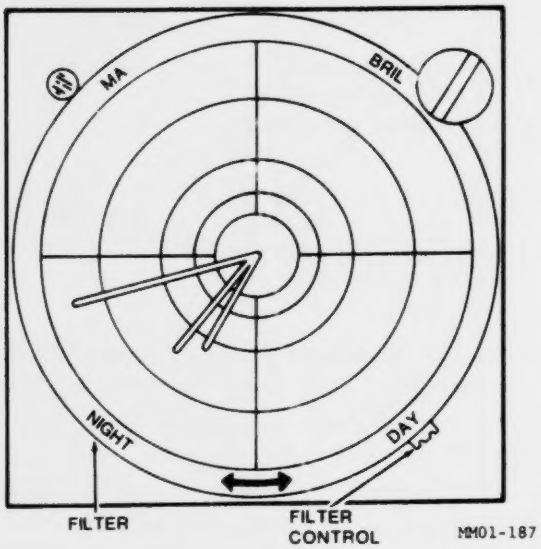


Figure 4-9. Discriminator On Mode Display

4-22. Self-Test Procedures (AN/APR-39V-1). The self-test confidence checks all AN/APR-39V-1 circuits except antennas, high-pass filters and detectors in the high band receivers, bandpass filter and detector in the low-band receiver, analysis signal commutator, and high and low-band blanking circuits. The self-test procedure is done before operation when any malfunction is detected. A typical self-test display is shown in figure 4-10.

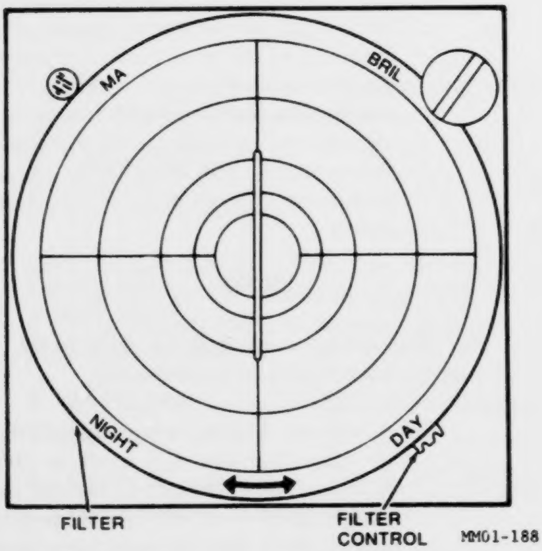


Figure 4-10. Typical Self-Test Mode Display

a. Apply power to the AN/APR-39. Control unit panel lights go on

b. Place control unit DSCRM switch OFF, PWR switch ON, and wait 1-minute for warmup. Monitor display CRT and audio and press and hold SELF TEST.

(1) FWD and AFT strobes appear, extending to about the third circle on the display graticule, and a 2.5 kHz (approximately) PRF audio is present immediately

(2) Within about 6 seconds, alarm audio is present and the MA light starts flashing.

(3) Turn display BRIL control cw and ccw. Strobes brighten (cw) and dim as control is turned. Set BRIL control for desired brightness level.

(4) Turn control unit audio control between max ccw and max cw Audios will not be audible at max ccw and clearly audible at max cw

(5) Release SELF-TEST All indications cease.

c. Place DSCRM to ON. Press and hold SELF-TEST.

(1) Within about 4 seconds a FWD or AFT strobe (either may appear first) and a 1.2 kHz (approximately) PRF audio will be present.

NOTE

Occasionally, during the period between pressing SELF-TEST and appearance of the first strobe, a distorted dot on the display and intermittent audio will be present. This is not a fault indication

(2) Within about 6 seconds, the other strobe will appear and the PRF audio frequency will double.

(3) Several seconds later alarm audio will be present and the MA light starts flashing.

(4) Release SELF-TEST. ALL indications will cease.

(5) Place control unit PWR switch as desired.

4-23. Operating Procedure (AN/APR-39V-1). The procedure for turning on the equipment is as follows:

CAUTION

To prevent damage to the receiver detector crystals, assure that the AN/APR-39V-1 antennas are at least 60 meters from active ground radar antennas or 6 meters from active airborne radar antennas. Allow an extra margin for new, unusual, or high power emitters.

1. PWR switch – ON, allow 1-minute for warmup.
2. BRIL and filter controls – Adjust as desired.
3. AUDIO control – Adjust volume as desired.
4. DSCRM switch – Set for mission requirement.
5. Stopping Procedure – PWR switch – OFF.

4-24. INFRARED COUNTERMEASURE SET (AN/ALQ-144(V)).

WARNING

Do not continuously look at the infrared countermeasure transmitter (figure 2-1) during operation, or for a period of over 1 minute from a distance of less than 3 feet. Skin exposure to countermeasure radiation for longer than 10 seconds at a distance less than 4 inches shall be avoided.

The countermeasures subsystem provides infrared countermeasure capability. The system transmits radiation modulated mechanically at high and low frequencies using an electrically heated source. A built-in test feature monitors subsystem operation and alerts the pilot should a malfunction occur. The subsystem is made up of a control panel on the right hand vertical instrument panel and a transmitter located on the fairing immediately aft of the main rotor. The countermeasures subsystem is interfaced to the pilot caution/warning panel to announce subsystem malfunction; caution segment IR JAM illuminates (figure 2-38). The infrared countermeasures subsystem receives 28 vdc power from the No. 2 essential dc bus and is protected by the IR JMR XMTR and IR JMR PWR circuit breakers located on the pilot overhead circuit breaker panel. When the control unit ON-OFF switch on the Radar/IR jammer control panel is placed in the ON position, the power distribution and control circuits are activated. The source begins to heat, the servo motor and drive circuits are energized, turning on the high and low speed modulators, and a signal is applied to stabilize subsystem operations before energizing the built-in test function. After a warmup period the stabilizing signal is removed, and the subsystem operates normally. Placing the ON-OFF control switch to OFF causes the power distribution and control circuits to de-energize the source and initiates a cool-down period. During the cool-down period, the servo motor drive circuits remain in operation, applying power to the motors that cause the modulators to continue turning and the IR JAM caution light segment to illuminate. After the cool-down period, the power distribution and control circuits de-energize, all subsystem voltages are removed and the IR JAM caution light segment will extinguish. The infrared countermeasures set is not monitored by FD/LS.

4-25. Radar/Infrared Countermeasures Subsystem Control Panel (Complete Provisions Only). Control of the infrared countermeasures set is provided by the control panel located on the pilot right vertical instrument panel (figure 2-9). The control panel has one, two position switch (ON/ OFF) for the infrared countermeasures subsytem. Power is applied to the infrared countermeasures set by placing the switch in the ON position. To turn the infrared countermeasures set off, place the switch in the OFF position.

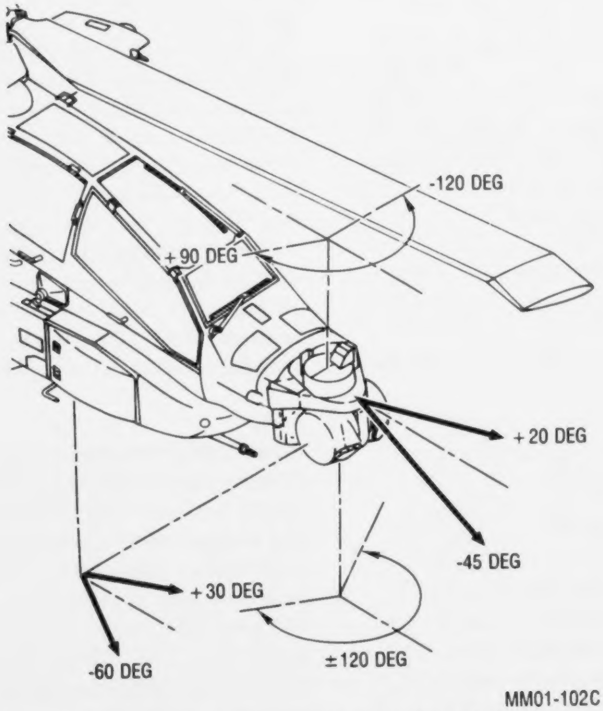
4-26. Radar Jammer Set AN/ALQ-136 (Complete Provisions Only). Control of the radar jammer set is provided on the radar/infrared countermeasure control panel located on the pilot right vertical instrument panel (figure 2-9). When the control switch is placed in the STBY position, the receiver/transmitter is placed in the ready mode thereby negating the requirement for warm-up time when the system is placed in the active mode by positioning the control switch to the ON position. When in this mode, the radar jammer automatically provides jamming power to the transmit antenna upon receipt of threat radar energy at the receive antenna. Placing the control switch to the OFF position removes all power to the radar jammer set. The radar jammer set receives 115 vac power from the No. 1 essential bus and 28 vdc power from the No. 2 essential dc bus and is protected by the JAM AC and JAM DC circuit breakers located on the pilot overhead circuit breaker panel. The radar jammer set is not monitored by FD/LS.

4-27. PILOT NIGHT VISION SENSOR (PNVS) (AN/AAQ-11).

WARNING

IFF transmission on the upper antenna may cause the PNVS to slew toward the fixed forward position and then back to LOS. If this occurs turn the transponder off, or use the lower antenna only during night NOE PNVS operation.

The pilot night vision sensor (PNVS) is used by the pilot for externally aided vision at night or during adverse weather. The PNVS consists of a stabilized FLIR contained in a rotating turret mounted above the TADS (figure 4-11). When selected, the turret is slaved to the crew member helmet LOS. This is accomplished using the IHADSS which also presents the FLIR image and symbology video to the crew member on the HMD. The PNVS image and symbology can be displayed on any of the displays in the helicopter through use of the VID SEL switch. Control of the PNVS turret is governed by the SIGHT SEL switch. Normal operation calls for the pilot to have priority control of the



MM01-102C

Figure 4-11. Designation Sight and Pilot Night Vision System

PNVS turret; however, in the event the pilot becomes incapacitated, the CPG may take control of the PNVS through use of the PLT/GND ORIDE switch, the CPG SIGHT SEL switch, and the collective NVS switch. Four degraded modes of operation exist when using the PNVS. In two of the degraded modes corrective action occurs automatically by the fire control system. The remaining two require pilot corrective action. In all degraded modes there will be a loss of some operational capability, as described in subparagraphs a thru d below.

a. In the event of a TADS Electronic Unit (TADS computer) failure, the PNVS will be placed in the direct mode automatically by the fire control system. The PNVS turret will be directly driven by the IHADSS sight electronics unit. PNVS turret motion may be limited to 75 degrees left and 75 degrees right in azimuth; turret motion may be erratic beyond the 75 degree azimuth position. The message PNVS...DIRECT will be displayed in the sight status block of the high action display of the symbology displayed to the pilot. No corrective action is required or available by the pilot.

b. In the event of a symbol generator failure, the fire control system will automatically command the IHADSS display electronics unit to display the PNVS FLIR 2 video image on the pilot CPG HDU. The PNVS will continue to function normally; however, the video displayed to the pilot will not have symbology. VDU video will blank and the recorder will be inoperative. Additionally, the CPG will receive TADS FLIR 2 video on the ORT. No corrective action is required or available by the pilot.

WARNING

If night or simulated night NOE, reaction to the following malfunctions must be immediate, exit of the NOE environment may be required.

c. In the event of a failure of the PNVS FLIR or turret assembly, the pilot must place the NVS switch on the collective switchbox in the TADS position. TADS will be slaved to the pilot helmet LOS and moded to WFOV FLIR. The slew rates of the TADS turret are noticeably slower than those of the PNVS and some gain and level adjustment may be required to obtain optimum image quality.

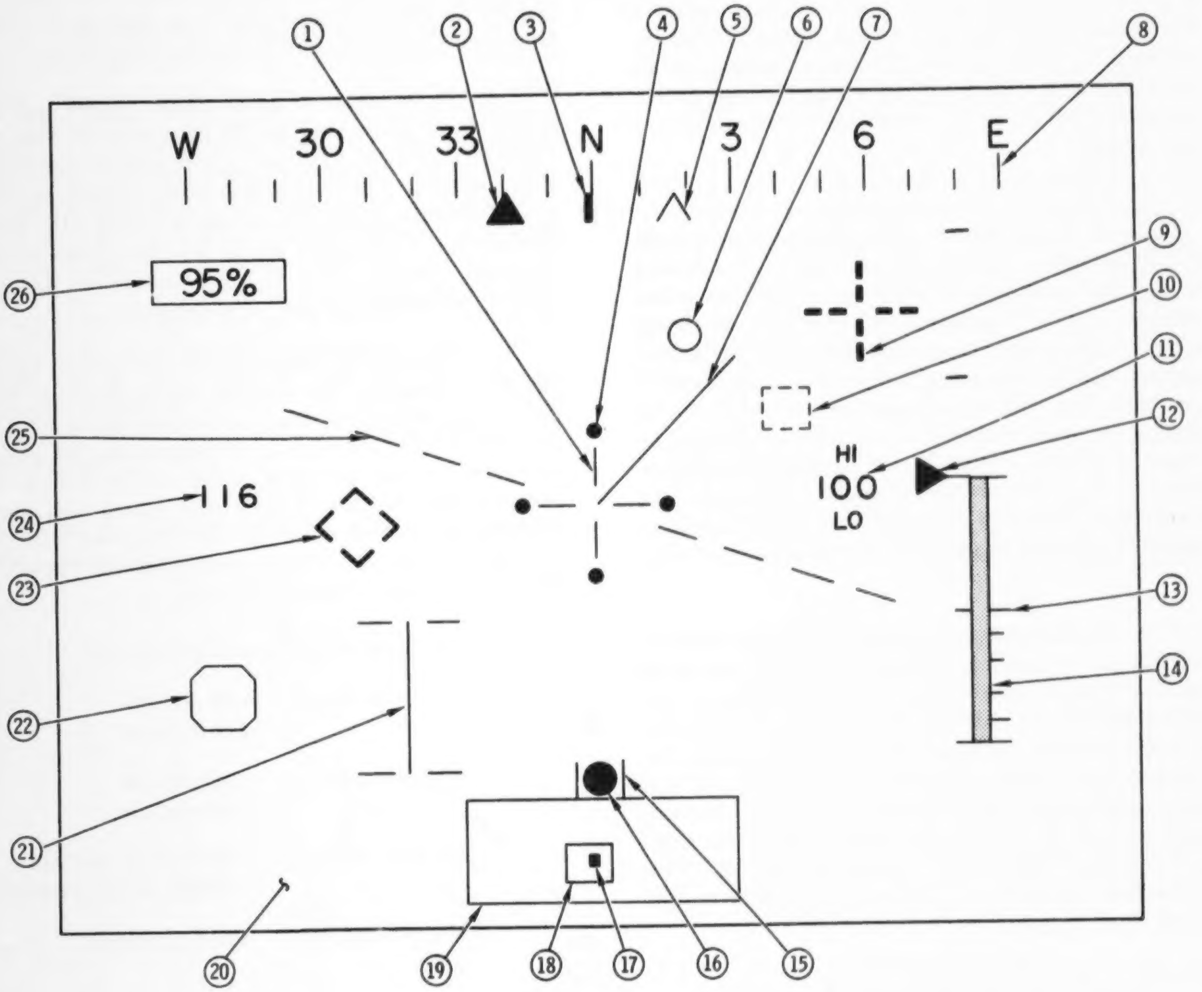
d. In the event of an IHADSS failure, either inability to command the PNVS turret or loss of video on the HDU, first the pilot must exit the NOE environment. Then place the VDU control switch in PLT and the ACQ SEL switch to NVS FXD. This configuration will allow the pilot to fly a fixed panel mounted display. Terrain flight capability will be directly dependent on pilot proficiency.

e. The PNVS receives 115 vac power from the No. 1 essential bus and 28 vdc power from the No. 3 essential dc bus and is protected by the PNVS AC and PNVS DC circuit breakers on the pilot overhead circuit breaker panel. The PNVS is continuously monitored by FD/LS which will illuminate the PNVS caution light segment for a PNVS malfunction. The on command test (test 09-PNVS) will fault isolate to the LRU.

(1) Equipment Data (figure 4-11).

Azimuth Range	+90 degrees –120 degrees
Elevation Range	+20 degrees –45 degrees
Field of View	30 degrees vertical 40 degrees horizontal
Maximum Slew Rate	120 degrees/sec

4-28. Flight Symbology (PNVS). The flight symbology has four modes; cruise, transition, hover, and bob-up. The symbology modes are shown in figure 4-12. The four modes are selectable using the flight symbology mode switch on the cyclic. The symbols are defined in table 4-1.


①
②
③
④
⑤
⑥
⑦
⑧
W
30
33
N
3
6
E
⑨
⑩
⑪
⑫
HI
100
LO
⑬
⑭
⑮
⑯
⑰
⑱
⑲
⑳
㉑
㉒
㉓
㉔
116
㉕
㉖
95%

MM01-128C

Figure 4-12. Flight Symbology Modes

Table 4-1. Symbology Definitions

Fig. 4-12 Ref No.	Fig. 4-18 Ref No.	Symbol Name	Description
1	M	LOS Reticle	Represents the line-of-sight of the crew member selected sight. The reticle will flash whenever the selected sight LOS is invalid or has failed. The reticle will also flash whenever the "ACTIONED" weapon is in a NO-GO state. The High Action Display will prompt the crew member for the appropriate condition.
2	A	Alternate Sensor Bearing	Indicates to the crew member the other crew member sensor relative bearing with respect to helicopter center line.
3	B	Lubber Line	Index indicates helicopter magnetic heading.
4	K	Cueing Dots	Indicate cued direction for target acquisition. All four dots present and flashing indicate IHADSS boresight is required.
5		Command Heading	Indicates heading to fly to next navigation waypoint designated by the doppler navigation system if bob-up mode of the flight symbology is selected.
	C	CPG LOS	Indicates relative bearing of CPG selected LOS.
6		Acceleration Cue	A vectorial representation of the helicopter longitudinal and lateral acceleration; the display origin is normally the end of the velocity vector. In the hover and bob-up modes, when the velocity vector exceeds its maximum scale, the display origin changes to the center of the LOS reticle. "The Acceleration Cue will flash when the HARS inertial platform has gone into free inertial mode, usually as a result of the LDNS going into memory."
7		Velocity Vector	A vectorial representation of the helicopter longitudinal and lateral ground velocities, in hover mode, maximum scale is 6 knots groundspeed in transition mode 60 knots groundspeed. The velocity vector will flash when the HARS inertial platform has gone into the free inertial mode.
8	D	Heading Scale	Helicopter magnetic heading scale.
9	E	Cued LOS Reticle	A virtual reticle indicating the cued LOS to the appropriate crew member. Used with the cueing dots.

Table 4-1. Symbology Definitions (cont)

Fig. 4-12 Ref No.	Fig. 4-18 Ref No.	Symbol Name	Description
10	F	Missile Constraints	Indicates the required orientation to aline the helicopter into constraints for Hellfire missile engagements. When all constraints for the mode of engagement are satisfied, the box will go from 'dashed' to 'solid'.
11	G	Radar Altitude	A digital display of radar altitude. Displays in 1- foot increments to 50 feet and in 10- foot increments above 50 feet.
12		Rate of Climb	An analog display of rate of climb moving along the left side of the vertical scale. Tick marks designate 500 and 1000 fpm rates of climb or descent.
13		Radar Altitude Vertical Scale	A vertical scale for the analog display of radar altitude. Tick marks designate 10-foot increments from 0 to 50 feet, and 50-foot increments from 50 to 200 feet. The scale is blanked when radar altitude is greater than 200 feet.
14		Radar Altitude Vertical Tape	An analog display of radar altitude moving within the vertical scale; also blanked above 200 feet.
15		Skid/Slip Lubber Lines	Represent the limits for 'ball centered' flight.
16		Skid/Slip Ball	Indicates the amount of skid or slip the helicopter is experiencing.
	Q	Selected Sensor	Displays the name of the TADS selected sensor. Also when FD/LS detects a fault in the continuous monitor mode, the message 'FD/LS' will alternately flash with the sensor name.
	O	TADS FOV Gates	Indicate the amount of the currently displayed imagery of TADS that will be displayed in the next narrower FOV.
17	I	Cued LOS DOT	Indicates the cued LOS location within the field of regard. The cued LOS DOT will flash when the HARS inertial platform has gone into the free inertial mode.

Table 4-1. Symbology Definitions (cont)

Fig. 4-12 Ref No.	Fig. 4-18 Ref No.	Symbol Name	Description
18	H	Field of View	Represents the instantaneous FOV of the crew member sensor within the field of regard.
19	J	Sensor Field of Regard	Represents the total gimbal limits possible for the respective crew member sensor.
20	N	High Action Display	Refer to paragraph 4-42.
21	P	Rocket Steering Cursor	Indicates the required orientation to aline the helicopter into constraints for 2.75 inch FFAR rocket engagements. During fixed or flight stow rocket delivery, a broken I beam will appear.
22		Hover Position Box	A display of the helicopter relative position when bob-up mode was selected. The box size represents an 8 foot square, maximum displacement is 48 feet laterally or longitudinally.
23		Head Tracker	Indicates the pilot head position relative the center line of the helicopter. This is a virtual symbol whose range of display is 30 degrees vertically and 40 degrees horizontally about the nose of the helicopter. When CPG selects PLT/GND OVRD and SIGHT SEL NVS then this symbol indicates his head position.
24	L	Airspeed	A digital display of true airspeed when the ADSS is turned on or not failed. If the ADSS is OFF or failed, display is ground speed in knots from the doppler navigation system. Range is 0 to 200, omnidirectional.
25		Horizon Line	Indicates pitch and roll attitude of the helicopter.
26		Engine Torque	Indicates the engine torque output by the engines. The magnitude is the larger of the two engine torque values. If a greater than 12% torque split occurs between engines, the displayed torque value will flash. At an engine torque value of 98% or higher, a box around the torque value flashes to indicate an impending engine torque limit. Symbolic torque value maximum is 120%.

4-29. COPILOT/GUNNER (CPG) CONTROL PANELS.

4-30. VIDEO RECORDER SUBSYSTEM (VRS).

The video recorder subsystem consists of an airborne video recorder located in the left side of the aft carry-through storage bay (figure 2-1) and the video recorder subsystem control panel (figure 4-13) located in the CPG left console (figure 2-12). The video recorder subsystem has the capability of recording up to 72 minutes of either the pilot or CPG selected video. Capability exists for playback onboard the helicopter for real time damage assessment and reconnaissance. The video recorder subsystem receives power from the No. 2 essential bus and is protected by the RCDR circuit breaker on the CPG circuit breaker panel. The video recorder subsystem is not monitored by FD/LS. The video tape recorded onboard the helicopter requires a special video playback unit to view the imagery off the helicopter. Controls and indicators are as follows:

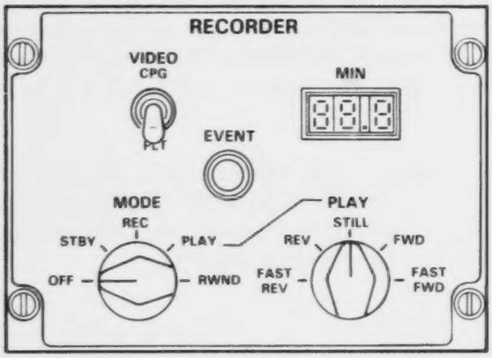


Figure 4-13. Video Recorder Subsystem (VRS), Control Panel

CONTROL/ INDICATOR	POSITION	FUNCTION
MODE	OFF	Disables all power to the VRS; commands the recorder to unthread the video tape casette.
	STBY	Enables power to the VRS and commands the recorder to thread the video tape cassette.
	REC	Places the recorder in the record mode. Actual recording starts or stops when the VID RCD switch on the ORT RHG is pressed.
	PLAY	Places the recorder in the play mode and activates the PLAY rotary switch for further commands. Automatically commands the symbol generator to display the recorder video on the CPG displays.
	RWND	Commands the recorder to rewind the video tape cassette; once commanded, the recorder will completely rewind the video tape prior to following any further commands.
PLAY		The switch will only be active when the MODE switch is in the PLAY position.
	FAST REV	Commands the recorder to fast reverse.

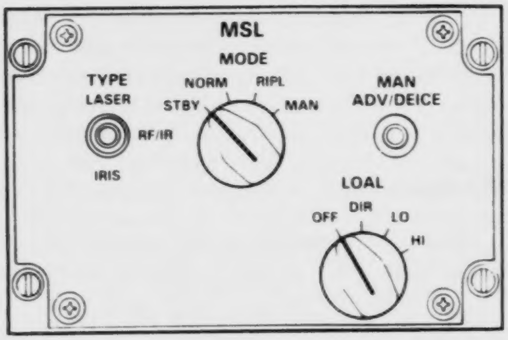
CONTROL/ INDICATOR	POSITION	FUNCTION
PLAY (cont)	REV	Plays back the recorded video in reverse on the CPG displays at normal speed.
	STILL	Freeze the video image.
	FWD	Plays back the recorded video in forward on the CPG displays at normal speed.
	FAST FWD	Fast forwards the recorder.
EVENT		A pushbutton switch which when pressed will place an event mark (EMK) and audio tone on the video tape.
VIDEO	CPG	Selects the CPG displayed video to be sent to the recorder when recording.
	PLT	Selects the pilot displayed video to be sent to the recorder when recording.
MIN		Tape remaining indicator; the value displayed is NOT in minutes or feet. It is a relative tape remaining indicator. At the beginning of the tape the indicator will read 00.0 and at the end will read 99.9.

4-31. Operation.

The VRS is turned on by placing the mode switch in the STBY position. When this occurs the tape recorder will thread the video cassette. Placing the mode switch in the REC position will arm the VID RCD pushbutton on the ORT RHG. Actuating the VID RCD pushbutton will turn on or off the recording of video. When recording video, whether pilot or CPG, the prompt RECORDER will be displayed in the sight status block of the CPG HAD and AND. To playback recorded video: place the mode switch to PLAY and select the desired playback method on the PLAY switch: still, rev, fast rev, fwd or fast fwd. If the mode switch is placed in the RWND position, the digital display, MIN, will automatically reset to 00.0 and the video tape recorder will start to rewind the cassette. Although the rewinding of the tape may be aborted by placing the mode switch in any other position, DO NOT use this position unless the intent is to completely rewind the tape because all elapsed counter references will no longer be valid. If an event mark is encountered during playback the video recorded will automatically stop and freeze the image, to proceed past the event mark, either forward or backward, place the PLAY switch in the still position and then reposition the PLAY switch to the desired playback method.

4-32. COPILOT/GUNNER MISSILE CONTROL PANEL.

The CPG missile control panel (figure 4-14) is located in the left console (figure 2-12) and receives its power as part of the overall missile system. Controls and functions are as follows:

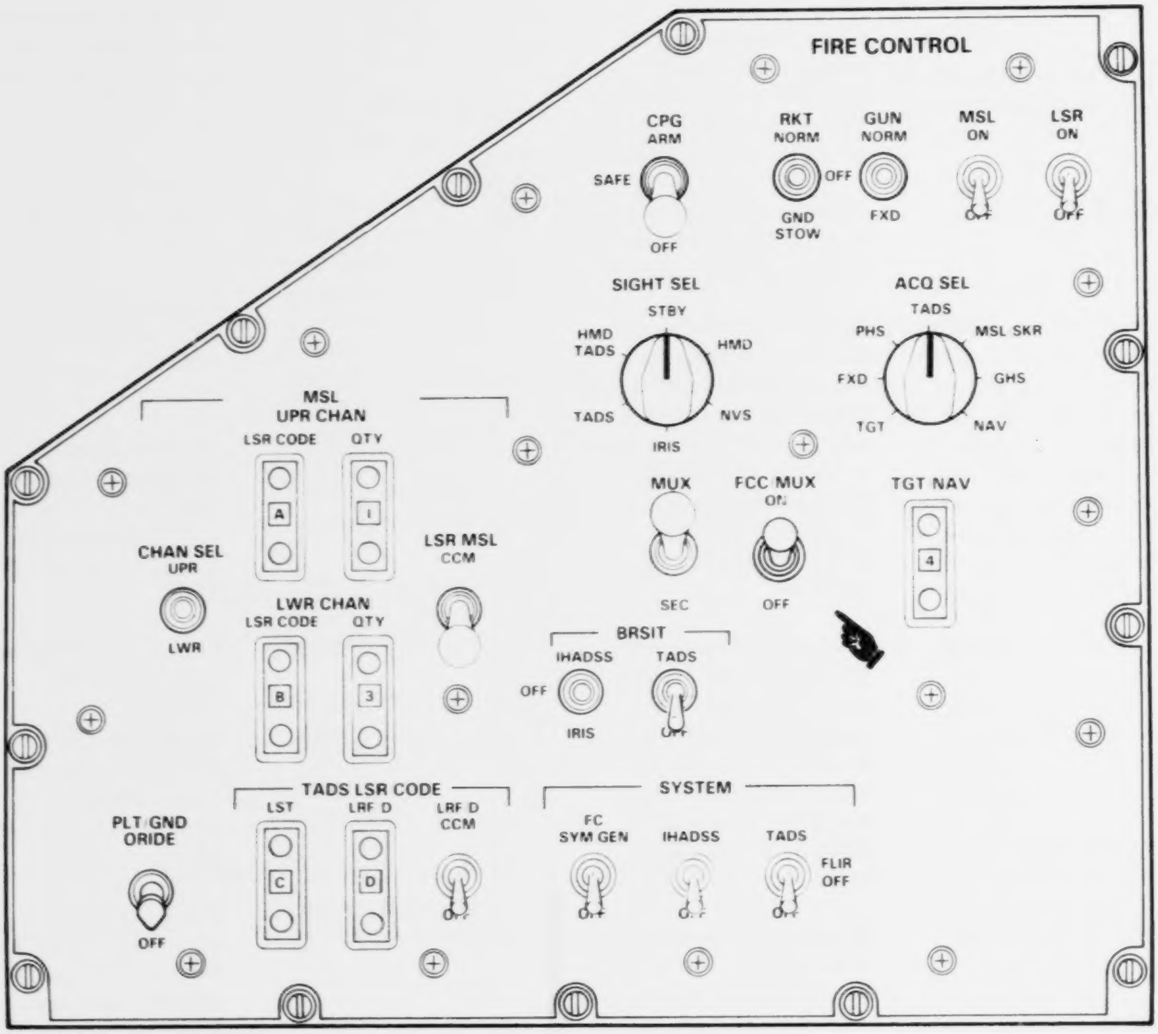


MM01-087B

Figure 4-14. Copilot/Gunner Missile Control Panel

CONTROL	POSITION	FUNCTION
TYPE	LASER	Specifies that laser seeker missiles are to be used for firing.
	RF/IR	Growth position for advance missile concepts; currently inactive.
	IRIS	Growth position for advanced missile concepts; currently inactive.
MODE	STBY	Places the missile system in standby mode.
	NORM	Places the missile system in normal mode in which only priority channel missiles can be fired.
	RIPL	Places the missile system in ripple mode in which priority and alternate channel missiles can be fired alternately.
	MAN	Permits manual advance of missile selection instead of using autoreplenishment.
MAN ADV/ DEICE		Used with the MAN position of missile mode to actually advance missile selection manually This DEICE mode is used to manually initiate the separation of the ice protection dome on the HELLFIRE missile. Separation will occur for the priority missile of the priority channel.
LOAL		This switch and related positions function identically to the pilot LOAL switch.

4-33. Copilot/Gunner Fire Control Panel. The CPG fire control panel (figure 4-15) is located in the left vertical instrument panel (figure 2-10) and receives power from the No. 1 essential bus and No. 3 essential dc bus; protection is provided by the FC AC and FC DC circuit breakers located on the pilot overhead circuit breaker panel. The CPG fire control panel is continuously monitored by FD/LS; the oncommand test (test 15-UTIL) will fault isolate to the LRU. Controls and functions are as follows:


FIRE CONTROL
CPG
ARM
SAFE
OFF
RKT
NORM
OFF
GND
STOW
GUN
NORM
FXD
MSL
ON
OFF
LSR
ON
OFF
SIGHT SEL
STBY
HMD
TADS
HMD
TADS
NVS
IRIS
ACQ SEL
TADS
PHS
MSL SKR
FXD
GHS
TGT
NAV
MSL
UPR CHAN
LSR CODE
QTY
A
1
CHAN SEL
UPR
LWR
LSR MSL
CCM
LWR CHAN
LSR CODE
QTY
B
3
MUX
SEC
FCC MUX
ON
OFF
TGT NAV
4
BRSIT
IHADSS
TADS
OFF
IRIS
OFF
PLT/GND
ORIDE
OFF
TADS LSR CODE
LST
LRF D
LRF D
CCM
C
D
OFF
SYSTEM
FC
SYM GEN
IHADSS
TADS
FLIR
OFF
OFF
OFF
OFF

MM01-082C

Figure 4-15. CPG Fire Control Panel

CONTROL	POSITION	FUNCTION
PLT/GND	OFF	Squat switch inhibits arm/safe power while on the ground. Airborne MASTER ARM switch controls arm/safe power.
	ORIDE	Squat switch overridden in all modes and CPG ARM switch controls arm/safe power for the aircraft.
CPG ARM	OFF	Disables all weapon control/firing circuits of the copilot/gunner.
	SAFE	Enables safe power to the CPG weapons select switches only if the MASTER ARM/SAFE switch is in arm or safe or if PLT GND ORIDE is in override. A green SAFE light indicates a valid safe condition.
	ARM	Enables ARM power to the CPG firing circuits only if the MASTER ARM/SAFE switch is in arm or if the PLT/GND ORIDE is in override. An amber ARM light indicates a valid arm condition.
RKT		All positions identical to the pilot.
GUN		All positions identical to the pilot.
MSL		All positions identical to the pilot.
LSR		The laser select switch provides power to the laser electronics and laser transceiver units. The laser cannot be fired unless a valid arm condition exists for the CPG and aircraft.
SIGHT SEL		Permits reference sight selection by the CPG.
	STBY	Deselects all lines-of-sight and stows sensors.
	HMD/TADS	Selects the helmet mounted display as the reference LOS and permits slaving of the TADS to the helmet LOS.
	TADS	Selects TADS as the reference LOS.
	IRIS	Selects the IRIS missile as the reference LOS; growth position, not currently active.
	NVS	Allows the CPG to view TADS FLIR wide field of view with flight symbology. The HMD helmet configuration is the only valid configuration for utilizaton of this position.

CONTROL	POSITION	FUNCTION
	HMD	Selects the helmet mounted display as the reference LOS. The HDU is active with CPG weapons symbology only. TADS may be slaved to the helmet, however imagery from the selected TADS sensor is not displayed.
ACQ SEL		Enables cueing or slaving to selected acquisition LOS when the slave pushbutton is actuated. Only the TADS may be slaved to a selected acquisition LOS, all others receive cueing.
	FXD	Defines the fixed forward position.
	TGT	Defines the waypoint/targeting routine as the acquisition source.
	NAV	Same as TGT position.
	GHS	CPG helmet LOS is defined as the acquisition source.
	MSL/SKR	The Hellfire missile seeker angles define the acquisition LOS.
	TADS	The TADS LOS is defined as the acquisition LOS. This mode is not active if the sight selected is TADS.
	PHS	The pilot helmet LOS is defined as the acquisition LOS.
CHAN SEL		Functions the same as the pilot channel select switch.
MSL UPR/ LWR CHAN		Labels used on the CPG fire control panel for set-up of two missile channels. Once a set-up has been made, the channel select switch is actuated either to upper or lower establishing that code and quantity set-up as the priority channel; by default, the other code and quantity set-up becomes the alternate channel.
	LSR CODE	Specifies the alphabetic laser code designator assigned to that channel set-up.

CONTROL	POSITION	FUNCTION
	QTY	Specifies the number of missiles per channel that are to be coded and brought to a ready state at one time. A maximum of three missiles is permitted per channel at one time.
LSR MSL CCM		The LSR MSL CCM switch located in lower center of the co-pilot-gunner's HELLFIRE Fire Control Panel, provides HELLFIRE weapons system hardening in the true or up position. The LSR MSL CCM switch position is set during the sequence of operations in which the code is loaded to a specific missile location. In the absence of enemy counter-measures, the CCM switch shall remain in the false or down position.
TGT/NAV		Numeric value in the window specifies the storage location of waypoint/targeting coordinate data. The range is 0 – 9.
BRSIT		Enables various sight or missile boresight modes.
	TADS	Places the TADS in internal boresight mode.
	OFF	Disables TADS internal boresight and returns to normal control.
	IHADSS	Enables IHADSS boresight for the CPG and turns on the boresight reticle unit.
	OFF	Disables all switch functions.
	IRIS	Enables boresight of IRIS missiles; growth position, currently inactive.
MUX		Specifies which bus controller will control the multiplex bus.
	PRI	Specifies the fire control computer.
	SEC	Specifies the backup bus controller. The normal position is PRI. In the event of failure of the FCC, switching to the BBC will occur automatically.

CAUTION

FCC/MUX switch shall always be left ON.

CONTROL	POSITION	FUNCTION
FCC/MUX	ON	Enables power to the FCC.
	OFF	Disables power to the FCC.
TADS LSR CODE	LST	This index specifies the alphabetic laser code designation to be assigned to the laser spot tracker.
	LRF/D	This index specifies the alphabetic laser code designation to be assigned to the LRF/D.

CONTROL	POSITION	FUNCTION
TADS LSR CODE (cont)	LRF/D CCM	Enables the last pulse logic range gate circuit. If erratic laser range readouts occur, enable the LRF/D CCM.
FC SYM GEN		Turns on the fire control symbol generator. Required for symbology generation and video switching onboard the aircraft.
IHADSS		Turns on the IHADSS and activates the IHADSS display electronics unit.
TADS		Turns on the TADS and initiates TADS FLIR cooldown.
	FLIR OFF	Powers TADS but does not cool down the FLIR; not normally used.
	OFF	Disables all power to the TADS.

4-34. DATA ENTRY KEYBOARD (DEK).

The data entry keyboard (figure 4-16) is located in the left console (figure 2-12) and receives power from the No. 1 essential bus and No. 3 essential dc bus; protection is provided by the FC AC and FC DC circuit breakers located on the pilot overhead circuit breaker panel. The DEK is continuously monitored by FD/LS; the oncommand test (test 15-UTIL) will fault isolate to the LRU. Controls and functions are as follows:

CONTROL	POSITION	FUNCTION
DATA ENTRY	OFF	Deactivates the keyboard.
	STBY	Power applied to keyboard and self test initiated, all inputs from the keyboard are ignored.
	RNG	Input of CPG range, manual or automatic, in meters, aircraft to target. Automatic range calculations are commanded by the input of 0 range. Maximum manual range entry: 31,999.
	FD/LS	Input to the fault detection/location system.
	CODE	Input of standard NATO/TRI-Service laser code data.
	TGT	Input of coordinate data for the waypoint/targeting subsystem.
	SP1	Input of data to the fire control computer.

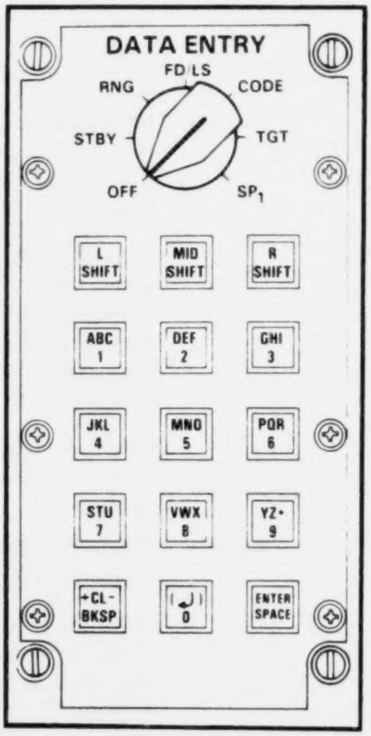


Figure 4-16. Data Entry Keyboard

4-35. Data Entry Keyboard Operation.

a.	To key in a letter:	First press the shift key corresponding to the relative location of the desired letter. Then press the key with the desired letter.
b.	To key in a number:	Press the desired key.
c.	To enter the keyed-in data:	Press any shift key. Then press the ENTER/SPACE key.

d. Special characters:

BKSP	Moves the cursor one position to the left.
CL	Clears the entire current input line and moves the cursor to the leftmost position.
(↵)	Advance to the first position of the next input line.
SPACE	Skip the next character position or perform automatic character inserts.

4-36. Optical Relay Tube (ORT) Controls and Displays.

The ORT (figure 4-17) is located between the left and right vertical instrument panels (figure 2-8) and receives power as part of the overall TADS

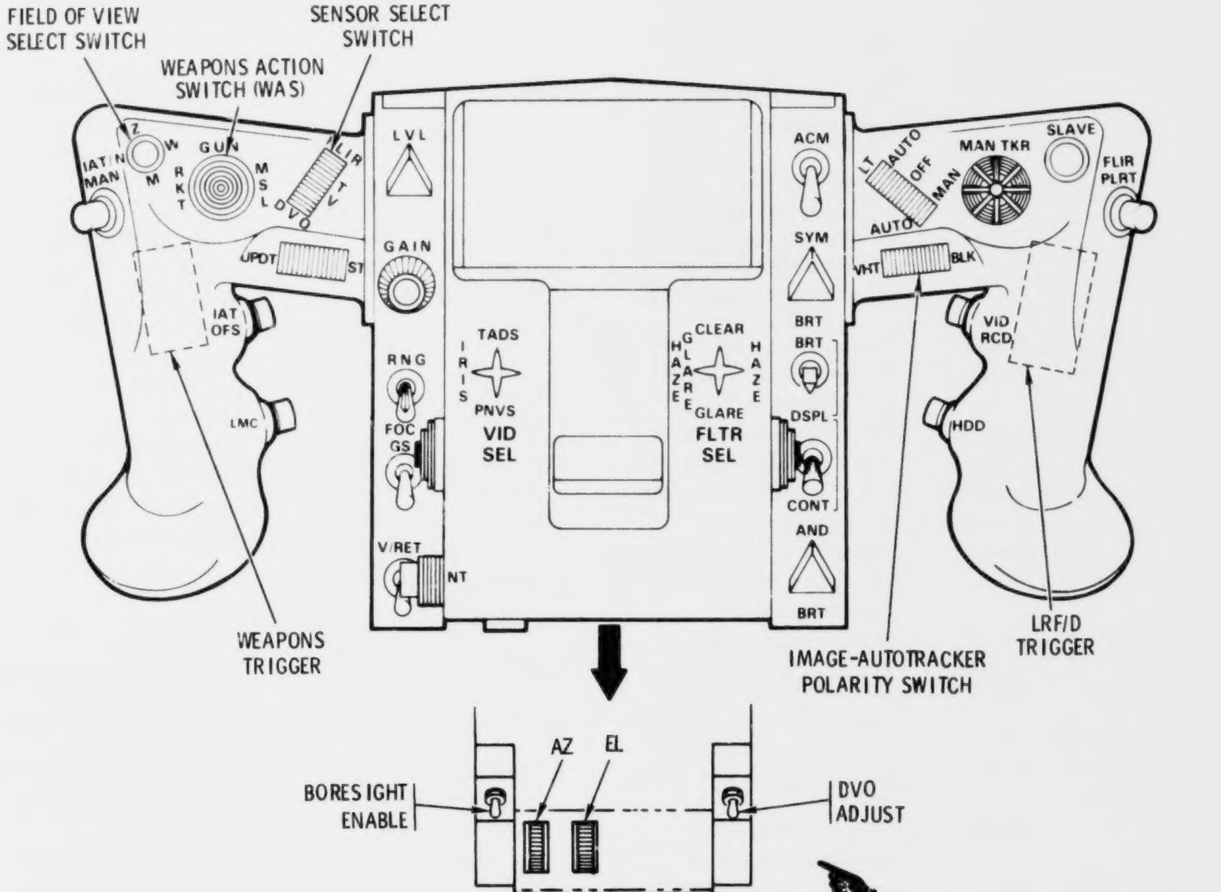

FIELD OF VIEW SELECT SWITCH
SENSOR SELECT SWITCH
WEAPONS ACTION SWITCH (WAS)
Z
W
M
GUN
RKT
MSL
IAT/MAN
FLIR
TV
DVO
UPDT
ST
IAT OFS
LMC
LVL
GAIN
RNG
FOC GS
V/RET
NT
TADS
IRIS
PNVS
VID SEL
CLEAR
HAZE
GLARE
HAZE
FLTR SEL
ACM
SYM
BRT
BRT
DSPL
CONT
AND
BRT
LT
AUTO
OFF
MAN
MAN TKR
SLAVE
FLIR PLRT
AUTO
WHT
BLK
VID RCD
HDD
WEAPONS TRIGGER
IMAGE-AUTOTRACKER POLARITY SWITCH
LRF/D TRIGGER
AZ
EL
BORESIGHT ENABLE
DVO ADJUST
MM01-092E

Figure 4-17. ORT and Hand Controls

system. The ORT is continuously monitored as part of the overall TADS FD/LS; the oncommand test (test 14-TADS) will fault isolate to the LRU. Controls and functions are as follows:

CONTROL/ DISPLAY	POSITION	FUNCTION
LEFT HAND GRIP		
IAT/MAN		Engages or disengages the image autotracker. On disengagement the TADS turret is placed in manual track.
Field of view select		Selects the field of view desired.
	W	Wide field of view.
	M	Medium field of view.
	N	Narrow field of view.
	Z	Zoom or underscan field of view.
WAS		Weapons action switch. Actions the selected armament and removes the electrical trigger interlock.
	RKT	Actions the Aerial Rocket Control System; pylons will articulate to commanded quadrant elevation and displays the rocket steering indicator. The ORT WAS in the RKT position defines the cooperative engagement mode.
	GUN	Actions the M-230E1 gun system and slaves the gun turret to the selected LOS.
	MSL	Actions the Hellfire missile system and displays constraints symbology.
Sensor select		Selects the desired sensor of TADS.
	DVO	Selects the direct view optics.
	DTV	Selects the day television.
	FLIR	Selects the FLIR.
UPDT/ST		Actuation signals the FCC to execute the update or store function of waypoint/ targeting.
IAT OFS		Engages offset track mode of the image auto tracker.
LMC		Turns on the linear motion compensation and rate integrator tracking aids.
Weapons trigger		Two-position guarded trigger which enables weapons firing. The first detent is for normal selected weapons usage; the second will override the selected weapons performance inhibits, but not the safety inhibits of the selected weapon.
LEFT SIDE OF ORT		
LVL		Adjusts the FLIR level.
GAIN		Adjusts the FLIR gain.
RNG FOC		Adjusts the narrow FOV focus in DTV or FLIR. Minimum distance that may be focused in narrow field of view is 500 meters.

CONTROL/ DISPLAY	POSITION	FUNCTION
GS		Activates the gray scale for the CPG.
VID SEL		Selects the video source to be displayed to the CPG.
	TADS	Displays the video from the CPG selected sight.
	PNVS	Displays the video from the pilot selected sight.
	IRIS	Displays the video from the IRIS missile; growth position, currently will mode the ORT displays for 525 line video format.
NT		Actuates the heads down display red night filter.
V/RET		This function has been deleted. The switch is inactive.
RIGHT SIDE OF ORT		
ACM		This switch is utilized to maintain optimum gain and level settings as a result of varying thermal scene content or when switching FLIR polarities.
SYM BRT		Adjusts the symbology brightness. Range is: bright white through black.
DSPL BRT		Adjusts heads up or heads down display brightness. When an IHADSS mode is selected on the SIGHT SEL this will adjust the HDU brightness.
DSPL CONT		Adjusts heads up or heads down display contrast. When an IHADSS mode is selected on the SIGHT SEL this will adjust the HDU contrast.
AND BRT		Adjusts alphanumeric display brightness.
FLTR SEL		Permits selection of various DVO filters to compensate for atmospheric conditions.
	CLEAR	Selects a clear filter.
	HAZE GLARE	Selects a haze/glare filter.
	GLARE	Selects a glare filter.
	HAZE	Selects a haze filter.
RIGHT HAND GRIP		
LT		Laser spot tracker engagement switch.
	AUTO	Arms the laser spot tracker and places the TADS turret into a four bar scan about the point of engagement.
	OFF	Disarms the laser spot tracker.
	MAN	Arms the laser spot tracker and leaves the turret in manual track mode.
Image auto-tracker polarity		Selects the contrast polarity for the image auto-tracker.

CONTROL/ DISPLAY	POSITION	FUNCTION
Image auto tracker polarity (cont)	WHT	Selects white on black contrast polarity.
	AUTO	Permits the tracker to automatically select the tracker polarity.
	BLK	Selects black on white contrast polarity.
MAN TKR		Thumbforce controller that controls slewing the turret during manual track mode. Slew rates are proportional to the sensor and FOV selected.
SLAVE		Actuates the slave latch to slave or cue the selected sight to an acquisition LOS.
FLIR PLRT		Allows switching of FLIR polarities; black or white hot.
VID RCD		Starts or stops the video recorder when the VRS is in REC or PLAY mode.
HDD		Turns off heads out display and turns on heads down display.
LRF/D trigger		Two-position guarded trigger. The first detent will fire a ranging burst and stop. If continuous range or designation is desired, press trigger to second detent.
Boresight Enable	UP	Enables the IAT during TADS internal boresighting or enables the AZ and EL pots during TADS outfront boresight.
	Center	Disables all functions.
	Down	Enables DVO boresight adjust switch.
DVO adjust		Three position, center maintain switch, used to slew the DVO boresight adjustment in a helical motion.

4-37. TARGET ACQUISITION DESIGNATION SIGHT (TADS) AN/ASQ-170.

a. **Description**. The TADS provides the CPG with day and night target acquisition by means of a direct view optical (DVO) telescope, a day television (DTV), and a forward looking infrared (FLIR) sensor system. The sensors may be used singly, or in combination, depending on the tactical, weather, and visibility conditions. Target tracking may be accomplished manually; automatically, using the image auto-tracker (IAT) or by using the laser spot tracker (LT). The laser spot tracker facilitates target handoff from another laser designator. Linear motion compensation (LMC) aids in the tracking of moving targets either manually or automatically. The image auto-tracker has the capability to offset track one target, while automatically tracking another target. The TADS receives 115 vac power from the No. 1 essential bus and 28 vdc power from the No. 1 essential dc bus and is protected by the TADS AC and TADS DC circuit breakers located on the CPG circuit breaker panel. The TADS is continuously monitored by FD/LS. oncommand test (test 14-TADS) will fault isolate to the LRU.

b. **Equipment Data (Figure 4-11).**

Azimuth Range	+ 120 degrees –120 degrees
Elevation Range	+ 30 degrees –60 degrees

Fields of View (diagonal measurement)

DVO

Wide	18.0 degrees

Narrow	4.0 degrees
DTV	
Wide	4.0 degree
Narrow	0.9 degree
Zoom	0.45 degree
FLIR	
Wide	50.0 degrees (identical to PNVS)
Medium	10.0 degrees
Narrow	3.1 degrees
Zoom	1.6 degrees
Maximum slew rate (WFOV FLIR)	60.0 degrees/sec

c. **Drift Null.** The TADS system has the capability to null the turret servo drift by either of two methods. Servo drift can be identified as happening whenever the TADS turret is under manual control and the CPG is not making any inputs with the thumbforce controller and the reticle appears to drift off the aim point. The aim point should remain within the narrow FOV of the DTV for 30 seconds. If it does not, or a lesser amount of drift is desirable, adjust as follows:

(1) **Manual Drift Null.** The manual drift null procedure can be accomplished when the helicopter is on the ground or during flight. First, select DTV or FLIR narrow FOV as the sensor; then, aim the reticle at an easily observed object. Place the Boresight Enable switch in UP position and wait for at least 5 seconds; then, use the AZ and EL thumbwheels to null the turret drift. When the servo drift is nulled, place the Boresight Enable switch in CENTER position and the procedure is complete.

(2) **Auto Drift Null.** Auto Drift null is active from the time the TADS is first turned on. The only time it is inactive is when the Manual Drift null procedure has been accomplished. If the manual procedure was accomplished, the Auto Drift null can be reactivated by placing the Boresight Enable switch in UP position for 2 seconds and then placing it back to CENTER position. Auto Drift null is not as precise as the manual procedure so some residual servo drift will always be present when it is active.

d. **Boresight.** Boresight procedures consist of cue update, internal boresight, outfront boresight, and manual boresight.

(1) **Cue Update.** Performance of cue update ensures that the TADS turret is in proper position relative to the boresight assembly prior to firing the laser. Cue update should be viewed, and if necessary adjusted, as part of preflight procedures prior to any firing of laser or weapons when TADS FLIR is used as the imaging sensor. If cue update is adjusted, outfront boresight must be performed following the cue update. Cue update procedure is contained in paragraph 4-51A, Cue Update.

(2) **Internal Boresight.** Performance of internal boresight aligns day TV and FLIR to laser LOS and DVO to day TV LOS. Internal boresight should be performed as part of preflight procedures prior to any firing of laser or weapons when TADS is used as imaging sensor. Internal boresight can also be performed in flight to ensure boresight accuracy without requiring outfront boresight as a followup. Internal boresight procedure is contained in paragraph 4-51B, TADS Internal Boresight.

(3) **Outfront Boresight.** Performance of outfront boresight ensures FLIR LOS is in coincidence with laser LOS. Outfront boresight should be checked as part of preflight procedures prior to any firing of laser or weapons when TADS FLIR is used as the imaging sensor. Outfront boresight must be performed after a cue update adjustment. Target requirements for the outfront boresight procedure are as follows:

(a) A target a minimum of 0.5 km away from the helicopter is required. Target must be clearly visible and trackable through both FLIR and TV sensor NFOV. Target must have the same center as viewed in both FLIR and TV sensors.

(b) Outfront boresight procedure is contained in paragraph 4-51C, TADS Outfront Boresight.

(4) **Manual Boresight**. The manual boresight procedure is used only to recapture or center the FLIR laser spot. It is not an acceptable boresight procedure for normal flight operations. Manual boresight procedure is contained in paragraph 4-51.D, Manual Boresight Adjust.

WARNING

The narrow and zoom FOV TADS FLIR imagery has inaccuracies for lasing or weapons direction following TADS internal boresight. TADS outfront boresight validation and adjustment (if necessary) shall be performed prior to using the TADS FLIR imagery for laser or weapons operations.

4-38. FAULT DETECTION/LOCATION SYSTEM.

The FD/LS is contained within the fire control computer program. The continuous monitor functions whenever power is applied to the FCC. If the BBC is the primary bus controller, no FD/LS capability exists. The function of the FD/LS is to detect faults in the subsystems monitored and announce the NO-GO conditions to the flight crew or fire control computer repairman. The FD/LS identifies the NO-GO subsystem component and its location within the helicopter. The data entry keyboard is utilized to access the FD/LS functions. There are two modes of the Fault Detection/Location Subsystem operation: continuous monitor; and command initiated. Most weapon, sensor, or fire control subsystems have a continuous check on their status and report their status to FD/LS without a command initiated test. If the FD/LS detects a NO-GO condition during the continuous monitor of any of the weapons, TADS or PNVS, the results are displayed on the pilot and CPG caution warning panel. If the exact status information regarding the NO-GO condition is desired, the DEK rotary switch must be rotated to the FD/LS position. The FD/LS will automatically display the status of all NO-GO subsystem components. The status list may be paged by pressing the SPACE key on the DEK. The FD/LS MENU will be displayed anytime a numbered key is pressed. The list is completed when the message "ANY KEY FOR FD/LS MENUS" appears on the display.

4-39. On Command Tests. Most command initiated tests are fully automatic and do not require any intervention between initiation and completion. There are certain tests which do require some interaction between the initiator and the fire control system. Interaction may require either switch actuation or evaluating a specific parameter or function and the decision regarding its acceptability. The interaction is fully prompted for all switch actions or evaluations. The command initiated tests are displayed as a menu of the specific tests. There are two pages of the test menu. They are:

01-ADS	05-HARS	09-PNVS
02-DASE	06-IHDS	10-PYLN
03-DICE	07-MSL	11-RKT
04-GUN	08-MUX	12-STAB

13-SYMG	17-APU
14-TADS	18-GEN
15-UTIL	19-TRAN
16-ETE	

These tests are initiated by entering the corresponding two-digit number for the test. Any required intervention is fully prompted and the results of the test are displayed on the TADS ORT, VDU and helmet mounted displays. The results may be paged by using the SPACE key; this should be done until the message "ANY KEY FOR FD/LS MENUS" is displayed. The FD/LS status or command initiated test may be accomplished without turning the TADS on. The TADS heads out display can be used independently of the TADS for FD/LS, by turning on the symbol generator, to display the FD/LS on command tests. The FD/LS tests may request of the operator an acknowledgement that an action has been completed, the method used to acknowledge (ACK) is to press the SPACE key on the data entry keyboard.

4-39.1. CBHK DATA VALIDATION.

NOTE

If the FCC battery fails boresight correctors will not be maintained.

a. The fire control computer continually monitors certain critical internal values derived from the Captive Boresight Harmonization Kit (CBHK) boresight correctors. These critical values are used in the correction or adjustment of line-of-sight and weapons aiming. In the event of any alteration of these internal FCC values, the flight crew will be notified of the affected sight or weapons subsystem by a message in the high action display and FD/LS continuous monitoring.

b. The appropriate message in the high action display will be displayed whenever the affected sight or weapon is selected. The FD/LS messages will be announced as part of the continuous tests described in paragraph 4-38, Fault Detection/Location Subsystem. The effect on the selected sight or weapon will be that no correction to the line-of-sight or weapon aiming based on the CBHK correctors will be made. The sight or weapon will fuction normally but without apparent boresight correction or alignment.

c. Validate the CBHK boresight correction values for the affected subsystem prior to subsystem utiilization.

To check the FCC boresight corrector numbers, proceed as follows:

Place the DEK mode select control to the FD/LS position. Enter the letter B (MID SHIFT then 1). The boresight menu page will be displayed as follows:

TADS	AL - 20	VF - 21	ED - 22
GUN	AL - 23	VF - 24	ED - 25
PYLN	AL - 26	VF - 27	ED - 28
PNVS	AL - 29	VF - 30	ED - 31

The edit column (ED) is located to the right of the align (AL) and verify (VF) columns and is the only column the pilot will reference. The alignment, verification, and edit numbers are established by armament personnel using the Captive Boresight Harmonization Kit (CBHK) during aircraft systems boresight.

To check the boresight numbers in the FCC against the boresight numbers on the boresight page in the aircraft logbook, the aircraft must be on the ground with the FCC operational. To check the TADS, GUN PYLN, or PNVS boresight numbers, enter 22, 25, 28, or 31 respectively. The selected system boresight edit numbers will be displayed in lieu of the menu page. For example, to check the PNVS boresight numbers, enter 31. The boresight menu will blank and the PNVS edit page will be displayed as follows:

PNVS CORRECTORS -MR-

EL + 09.3 AZ -15.6

If the FCC numbers displayed match the logbook numbers, proceed to another system by entering a B in the DEK which recalls the boresight menu and enter the next appropriate edit number for the desired system. The PYLN (ED - 28) data is displayed as one pylon number per page across four pages. To move from one pylon to the next sequentially, press the ENTER key and the next pylon in sequence (1-4 repeated) will be displayed.

If the FCC numbers displayed are not the same as the logbook numbers, the pilot must change the values to match the logbook values. The protocol used to access the edit numbers assigns an integer (1, 2, 3, 4 . . .) to data locations on the page following the rule: left to right, top to bottom. The top left data location is addressed by entering a 1 in the DEK. The next data location to the right is addressed by a 2 in the DEK, etc. When a data location is addressed by the appropriate integer entry in the DEK, the flashing cursor will move from the top left corner to the first digit in the data location. For example, using the PNVS page from above, if the elevation (EL) numbers were correct but the azimuth (AZ) numbers were not the same as the logbook values, the pilot would access the azimuth location by entering a 2 in the DEK. The flashing cursor would relocate beneath the 1 in -15.6. Type in the logbook values. If the plus (+) or minus (–) sign is not correct, use the BKSP key to move the cursor beneath the sign and make the appropriate correction to match the logbook values.

4-40. WEAPONS SYMBOLOGY.

The weapons symbology is displayed to the CPG on the video from the selected sight. The symbology is shown in figure 4-18. Refer to table 4-1 for symbol definition.

4-41. FIRE CONTROL SYSTEM MESSAGES.

The fire control system displays to the crewmembers messages and prompts for management of the subsystems onboard the helicopter. The messages and prompts are displayed in the high action display or the alphanumeric display contained in the TADS ORT.

■ 4-42. HIGH ACTION DISPLAY (HAD).

The high action display provides information to the pilot and CPG for use in operation of the mission equipment. The high action display is located along the bottom of the displayed symbology and is split into two fields by the gimbal limits box. The two fields on either side of the gimbal limits display are further subdivided for a total of four message fields: sight status, and range and range source on the left, and opposite crew station weapon control and weapons status are on the right. Tables 4-2, 4-3, 4-4, and 4-5 list the messages and location. The high action display is shown in figure 4-19.

Table 4-2. High Action Display Sight Status

Crew Member	Message	Description
P/CPG	IHADFAIL	The IHADSS has been detected as NO-GO for that crew station by FD/LS. The IHADSS LOS defaults to fixed forward for the affected crew station.
P/CPG	BORESITE . . . REQUIRED	IHADSS boresight required.
P/CPG	IHADSLOS . . . INVALID	The IHADSS SEU has computed an invalid LOS for that crew station. This can be caused by the crew members head outside of the head motion box or blockage of the line-of-sight between the SSU and the helmet. The IHADSS LOS is frozen at the last valid computation until the LOS is computed as valid.
P	PNVSFAIL	FD/LS has detected the PNVS turret or electronics as NO-GO.
P	PNVS NOT . . . COOLED	The PNVS FLIR has not cooled down for optimum performance; cool down time should not exceed 15 minutes.
P	PNVS . . . DIRECT	FD/LS has detected the TADS Electronics Unit (TADS computer) as NO-GO. The PNVS turret is being directed by the IHADSS SEU. The PNVS turret azimuth range may be limited to 75 degrees left and right.
P/CPG	LIMITS	The PNVS or TADS is at a gimbal limit.
P/CPG	FORWARD	PNVS or TADS has been slaved to fixed forward through use of the ACQ SEL switch.
P/CPG	PNVSBST?	The FCC has detected an alteration of internal values affecting the PNVS alignment. The PNVS will function normally but without alignment correction.
P/CPG	TADSBST?	The FCC has detected an alteration of internal values affecting TADS boresight harmonization. The TADS will function normally but without CBHK correction.
P	INVALID . . . CPGLOS	ACQ SEL switch is in the CPG position and there is no valid CPG LOS.
P	UP=? LO=?	Pilot has actioned the missile system. If a ? is present, no missiles are coded and ready. When the missiles are coded and ready or tracking, the code letter will be displayed. The code of the priority channel will flash.

Table 4-2. High Action Display Sight Status (cont)

Crew Member	Message	Description
CPG	TADSFAIL	FD/LS has detected the TADS system as NO-GO.
CPG	FLIR NOT . . . COOLED	The TADS FLIR has not cooled down sufficiently for optimum performance; cool down should not exceed 15 minutes.
CPG	FLIR OFF	TADS FLIR is turned off, but FLIR has been selected as the sensor.
CPG	MSL LNCH	A missile has been launched for a remote designator.
CPG	SIM LNCH	A training missile has been launched for a simulated remote designator.
CPG	TOF = XX	The time-of-flight remaining for the missile launched for the remote designator.
CPG	FIRE . . . MISSILES	A subsequent missile may be fired for the remote designator.
CPG	LASE 1 . . . TARGET LASE 2 . . . TARGET LASE 3 . . . TARGET LASE 4 . . . TARGET THRU LASE 16 . . . TARGET	The remote designator must have his laser on for missile terminal guidance. The crew member may use this message to cue the remote designator when to turn on the laser.
CPG	EOT	End of tape. The video tape cassette is at the end; no tape remains.
CPG	BOT	Beginning of tape. The VRS has completely rewound the video tape cassette.
CPG	RECORDER	The video recorder has been selected and is operational.
CPG	RCDR FAIL	The video recorder has been selected and has been detected as NO-GO.
CPG	INTERNAL . . . BORESITE	The TADS internal boresight has been selected by having the BRSIT TADS/OFF switch placed in the TADS position.
CPG	OUT-FRNT . . . BORESITE	The TADS out-front boresight has been selected by having the IAT tracking when the BRSIT TADS/OFF switch is placed in the TADS position.
CPG	CUE UPDT . . . BORESITE	The TADS cue update boresight has been selected by having the IAT in manual and the SLAVE latched Low when the BRSIT TADS/OFF switch is placed in the TADS position.

Table 4-2. High Action Display Sight Status (cont)

Crew Member	Message	Description
CPG	INVALID . . . PLT LOS	ACQ SEL switch is in the PLT position and there is no valid PLT LOS.
CPG	TGT = X	Indicates selected address in the target NAV indexer (0 – 9). If X is replaced by a ?, no data is stored in target location.

Table 4-3. High Action Display Range and Range Source

Crew Member	Message	Description
NOTE The Fire Control Computer (FCC) is controlling the MUX whenever the symbol located between Kilometers and tenths of Kilometers is a colon (:). The Backup Bus Controller (BBC) in control is indicated by a period (.) instead of a colon.		
P	AX . X	The range being used is an automatic solution based on the selected sight LOS and radar altitude. The letter A is set in the leftmost RNG-KM thumbwheel on the ARCS panel. Range displayed is in kilometers.
CPG	AX . X	The range being used is an automatic solution based on selected sight LOS and radar altitude. The value 0 is entered through the DEK RNG data entry to command the automatic range solution. Range displayed is in kilometers.
P	MX . X	A manual range has been entered using the RNG-KM thumbwheels on the ARCS panel. Range displayed is in kilometers.
CPG	MX . X	A manual range has been entered through the DEK RNG data entry. Range displayed is in kilometers even if range entered was in meters.
CPG	NX . X	The fire control system has computed the range to the target or waypoint indicated in the TGT/NAV indexer. This range will increase or decrease dynamically with helicopter ground track. Commanded by placing the ACQ SEL switch in the TGT or NAV position. The displayed index storage location must have valid coordinate data. Range displayed is in kilometers.
CPG	XXXX	Laser range is being used by the CPG. The displayed laser range will increase or decrease for about 7 seconds after stopping the laser. The increase or decrease in range is based on the helicopter ground track relationship with the object lased. Laser range is in meters.
CPG	XX . X	CPG range display for any range source above if the range value is 10.0 KM or more.
P	3.0	This is the pilot's default range the fire control system will use for PLT range in the event no other range is available.
CPG	2.0	This is the copilot/gunner's default range the fire control system will use for CPG range in the event no other range is available.
P/CPG	10.0	AUTO RNG default range. Indicates selected LOS is looking higher than 1° below horizontal or altitude is less than 33 feet AGL.

Table 4-4. High Action Display Weapons Status

Crew Member	Message	Description
P/CPG	WEAPON?	The weapons trigger has been pulled without "actioning" a weapon.
P/CPG	RKT FAIL	The rocket subsystem has been checked and is in a NO-GO state.
P	CPG MSL	The CPG has actioned the missile system and has outprioritized the pilot's rocket system action.
CPG	PLT MSL	The pilot has actioned the missile system and has outprioritized the CPG's rocket system action.
P/CPG	ROCKETS	The rocket system has been actioned with neither crewmember RKT select switch in GND STOW and airspeed less than 100 KTAS as sensed by the ADSS.
P/CPG	RKT-G-S	The rocket system has been actioned, but one crewmember RKT select switch in GND STOW and airspeed less than 100 KTAS as sensed by the ADSS.
P/CPG	RKT-F-S	The rocket system has been actioned and the airspeed is 100 KTAS or greater as sensed by the ADSS.
P/CPG	TOF = TT	The trigger has been pulled and the rockets have been launched. Message indicates time of flight to impact, in seconds, remaining.
P/CPG	GUN FAIL	The gun system has been actioned but has been detected as NO-GO.
P/CPG	LIMITS	The gun system has been actioned but the weapon has reached an azimuth or elevation limit.
P/CPG	RNDS DDDD	The gun system has been actioned and the DDDD indicates the number of rounds remaining and will count down one unit for each firing PULSE.
CPG	MSL FAIL	The missile system has been actioned but has been deleted as NO-GO.
P/CPG	INVALID... COMMAND	The remote Hellfire electronics has detected an improper command from a crew member to the Hellfire missile system. This message is displayed for 2 seconds.

Table 4-4. High Action Display Weapons Status (cont)

Crew Member	Message	Description
P/CPG	BIT IN . . . PROGRESS	The RHE is performing BIT.
P/CPG	HANGFIRE	The missile fire signal was sent but umbilical separation did not occur at the predicted time. This message is displayed for 6 seconds, during which time all missiles on that side of the helicopter become "not available" and are inhibited from firing.
P/CPG	GUNBST?	The FCC has detected an alteration of internal values affecting gun boresight harmonization. The gun will function normally but without boresight corrections.

Table 4-4. High Action Display Weapons Status (cont)

Crew Member	Message	Description
P/CPG	MSL LNCH	The missile system is functioning properly and the weapons trigger has been pulled. This message is displayed for 2 seconds.
P/CPG	TOF = TT	Time of flight in seconds to missile impact, decrementing. If more than one missile is in flight, the display will show TOF for the missile first launched, then subsequently launched missiles.
P/CPG	FIRE...MISSILES	The minimum launch separation time has elapsed in a rapid fire missile engagement. The prompt is displayed whenever more than one missile is present on the priority channel after launch of a missile. This message is displayed for 2 seconds.
P/CPG	SIM LNCH	Displayed if training missiles are being used in place of MSL LNCH. This message is displayed for 2 seconds.
P/CPG	RF ORIDE	Growth position for RF/IR missile seekers.
P/CPG	2 CHANLS...TRACKING	Missiles selected on each channel have locked onto and are tracking laser energy of two different codes.
P/CPG	PRI CHAN...TRACKING	Missiles selected on the priority channel have locked onto and are tracking laser energy.
P/CPG	ALT CHAN...TRACKING	Missiles selected on the alternate channel have locked onto and are tracking laser energy.
		If no channels are tracking, the weapon status section will display the delivery mode and the firing delivery messages which are "HI", "LO", "DIR", or "LOBL". The fire delivery messages are "NORM", "STBY", "MANL", or "RIPL" (i.e., "LOBLNORM").
P/CPG	LASE 1 . . . TARGET LASE 2 . . . TARGET LASE 3 . . . TARGET LASE 4 . . . TARGET THRU LASE 16 . . . TARGET	The laser designator must be lasing the target for missile terminal guidance. This message is displayed during the last 8 seconds of the calculated missile time of flight in place of the TOF-TT message.
P/CPG	MSL SEL?	Missiles have been "ACTIONED", but no missiles have been selected.
P/CPG	ZONE?	Rockets have been "ACTIONED", but no zone has been selected for firing.

Table 4-5. High Action Display Opposite Crew Station Weapon Control

Crew Member	Message	Description
P/CPG	SIGHT?	A weapon system has been actioned but the SIGHT SEL switch is in STBY.
P/CPG	PYLNBST?	The FCC has detected an alteration of internal values affecting pylon boresight harmonization. The pylons, rockets and missile subsystems will function normally but without pylon CBHK corrections.

4-43. Alpha/Numeric Display (AND). The AND provides information to the CPG for use in the operation of the mission equipment. The AND is located below the heads-down-display in the ORT. The display is continuously visible to the CPG whenever he views heads down. The display fields are outlined in Figure 4-20. In the event of an AND failure, the Alpha/Numeric Display information may be symbolically duplicated on the TADS displays by placing the DEK rotary switch in the SP1 position and keying-in an "I". The AND information will then be duplicated on the selected TADS display in the same orientation as on the AND. The following table lists the messages and visual location.

SIGHT STATUS SECTION

RECORDER	The ORT VID RCD switch has been pressed and the recorder is operating.
RCDRFAIL	The ORT VID RCD has been pressed; however, the recorder has malfunctioned.
NON TADS	PNVS is the sight in use.
TADS FAIL	
TV FAIL	
FLIR FAIL	
IRISFAIL	
TADS... BORESITE	The boresight mode is in effect.
IRIS... BORESIGHT	
LIMITS	The TADS is at an azimuth or elevation gimbal limit.
PILOT... CONTROLS... TADS	
IMPEND... LASER... INHIBIT	
LASER... INHIBIT	
INVALID... PILOTLOS	
SLAVE PL	The acquisition select switch is in PLT.
SLAVE TG	The acquisition select switch is in TGT.
SLAVE NV	The acquisition select switch is in NAV.
INVALID... TARGTLOS	There are no valid UTM coordinates in the FCC for the target number selected on the thumbwheel switch.
INVALID... NAV LOS	
SYMBOL G	The symbol generator has been detected as NO-GO.
KBRDFAIL	The data entry keyboard (DEK) has been detected as NO-GO.

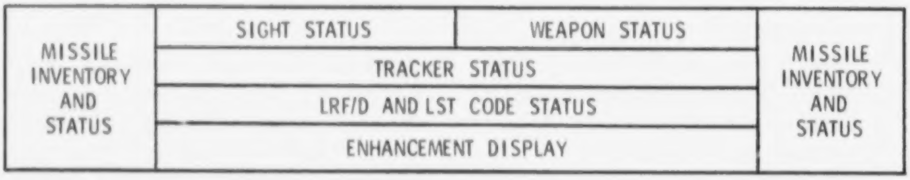

MISSILE INVENTORY AND STATUS
SIGHT STATUS
WEAPON STATUS
TRACKER STATUS
LRF/D AND LST CODE STATUS
ENHANCEMENT DISPLAY
MISSILE INVENTORY AND STATUS

Figure 4-20. Alpha/Numeric Display (AND)

SIGHT STATUS SECTION (cont)

TADS TEMP	The TADS has been selected and the turret internal temperature has been detected as overheating.
TADS NOT . . . READY	The TADS has been selected and the turret internal temperature has not reached operating temperature.
LRFD . . . COOLANT	The TADS LRF/D power is on and the transceiver coolant level has been detected as low. The LRF/D temperature is above maximum limit.
ENRGY LO	The TADS LRF/D power is on and the output energy level has dropped below a specified level.

WEAPON STATUS SECTION

WEAPON?	A weapons trigger has been pulled without a weapon selection.
GUN FAIL	
TADS FAIL	The selected video is not operational.
RNDSDDDD	
RKT FAIL	The rocket subsystem has been checked and is in a NO-GO state; message blinks at a 2 Hz rate.
ROCKETS	The WAS is in the rocket position, and the weapon trigger has not been pulled.
TOF = TT	The WAS is in the rocket position. The trigger has been pulled. The message indicates the time of flight to impact in seconds, decrementing.
MSL FAIL	
INVALID... COMMAND	
NO TYPE	The type of missile selected on the missile control panel is not present on the launchers.
BIT IN... PROGRESS	
PLT MSL	The pilot has control of the missile system.
HANGFIRE	
MSL SEL?	Missiles have been "ACTIONED" but no missiles have been selected.
ZONE?	Rockets have been "ACTIONED" but no zone has been selected for firing.
MSL LNCH	
FIRE... MISSILES	
SIM LNCH	A training missile is being utilized.
TOF = TT	The WAS is in the MSL position. The trigger has been pulled. Time of flight in seconds to impact, decrementing.
RF ORIDE	
2 CHANLS... TRACKING	
PRI CHAN... TRACKING	
ALT CHAN... TRACKING	

If no channels are tracking, the weapon status section will display the delivery mode and the firing delivery mode. The delivery messages are "HI", "LO", "DIR", or "LOBL". The fire delivery messages are "NORM", "STBY", "MANL", or "RIPL" (i.e., "LOBLNORM").

TRACKER STATUS SECTION

TADS... STOWED	The TADS is either stowed or in an internal boresight mode.
TADS... FORWARD	
LST FAILED	
LST TRACKING	LST tracking remotely designated laser energy.
LST SEARCH	Manual search.
LST AUTO SEARCH	LST scanning in a programmed search pattern.
IAT FAILED	
IAT BREAK-LOCK	Image auto tracker has broken track.
IAT OFFSET	IAT offset tracking engaged.
IAT TRACKING	
IAT B/W	IAT polarity is black on white.
IAT W/B	
IAT AUTO	
ENERATOR	The symbol generator has been detected as NO-GO.
RKT-G-S RKT-F-S LIMITS SIGHT? LASE 1 . . . TARGET LASE 2 . . . TARGET LASE 3 . . . TARGET LASE 4 . . . TARGET thru LASE 16 . . . TARGET	

LST AND LRF/D CODES STATUS SECTION

If neither system is operable, the section is blanked.

CODE

LST = C RFD = D
Both systems are operational and the code selected by the FCP pushbutton is displayed for each.

RFD = D
The LST is not operational but the RFD is operational.

LST = C
LRF/D is not operational but the LST is operational and code selected is "C".

LSR CCM
The LRF/D has detected a multiple target return while ranging or designating. The proper action is to engage laser countermeasures devices.

ENHANCEMENT DISPLAY SECTION

FIXD IMPACT RTCL
Rocket Action – Gun Action.
Rocket fixed or gun fixed.

UP = ? PRI LOW = ?
No missiles ready.

UP = A < < PRI LOW = B
Priority channel is upper. Upper code is "A" with missile(s) ready. Lower channel missiles are ready.

UP = ? PRI > > LOW = H
No missiles ready on upper channel. Priority channel is lower and lower code is "H" with missile(s) ready.

MISSILE INVENTORY AND STATUS SECTION

The following displays will be presented based on the position of the TYPE switch on the missile panel and the types of missiles loaded.

L	Laser missile
I	IRIS missile
R	RF/IR missile
A through H	Code of laser missile in place of the "L" indication.

The following characters will be displayed based on the status of a missile. The single status characters are displayed below the inventory type or code characters. The multiple character status indicators utilize both positions.

Missile Status	Description
S	Selected
R (steady)	Ready
R (flashing)	LOAL priority missile, next missile to be launched.
T (steady)	Missile seeker in track mode.
T (flashing)	LOBL priority missile, next missile to be launched.
M U	Missile is unlatched on launcher
M F	Missile has failed BIT or has been detected as failed subsequent to BIT
S F	Missile launch station detected as failed.
T F	Pylon MRTU cannot communicate with selected missile. Once detected for one missile on a particular launcher, all missiles present on that launcher will reflect this status. This status may be cleared by moding the missile system to STBY and then moding again to desired mode. The remote Hellfire electronics will attempt to communicate with the missiles on that launcher.
N A	Missile status has been determined to be: Not Available Low Coolant Hangfire in process Missiles that are: Selected, Ready, or Tracking on the same side of the aircraft as a missile that is hangfiring will reflect a 'Not Available' status for six seconds (0:06) from onset of hangfire. After six seconds the missiles will revert to their previous status.
M A	Missile launch sequence has aborted or missile has misfired.

WARNING

This is a valid indication of misfired ordnance. Appropriate safety and ordnance disposal procedures shall be accomplished.

M H	Missile is in the process of hangfiring or has hangfired.

WARNING

This is a valid indication of malfunctioning ordnance. Appropriate emergency procedures shall be accomplished.

Launcher Status

F F A A I I L L	Launcher has failed BIT or the serial/digital data link between the pylon MRTU and the launcher has failed.
S S A A F F E E	Launcher ARM/SAFE switch is in the SAFE position and may be armed by taking the aircraft ARM/SAFE to ARM and back to SAFE.

Section II. ARMAMENT

4-44. AUTHORIZED ARMAMENT CONFIGURATIONS.

For authorized configurations, refer to figure 7-60.

4-45. Armament Description.

a. **M-230E1, 30mm Area Weapon System.** The M-230E1, 30mm gun (Figure 4-21) is a single barrel, externally powered, chain drive weapon using M 788/789 or ADEN/DEFA type ammunition. The 30mm gun is mounted in a hydraulically driven turret capable of slewing the gun 110 degrees left or right of the helicopter centerline and up 11 degrees to 60 degrees down. In the event of loss of hydraulics, the turret will lock in the current azimuth position and the gun will return to the elevation stow position of 11 degrees up. The rate of fire is set for 600 to 650 rounds per minute. The maximum capacity of the linkless storage subsystem is 1200 rounds. The gun duty cycle is as follows: six 50-round bursts with 5 seconds between bursts followed by a 10-minute cooling period. For bursts limiter settings other than 50, the duty cycle can be generalized as no more than 300 rounds fired within 60 seconds before allowing the gun to cool for ten minutes, after which the cycle may be repeated. The FCC limits the fire control solution to a maximum range of 4500 meters. The maximum range of the 30mm gun is approximately 4000 meters.

b. **2.75 Inch Aerial Rocket Control System (ARCS).** The ARCS (figure 4-22) is a light antipersonnel assault weapon. The ARCS consists of a rocket control panel located in the pilots station and four station directors located in each of the four wing station pylons. The ARCS permits the pilot to select the desired type of 2.75 inch folding fin aerial rocket (FFAR) warhead, fuze, quantity, and range. The M-261 lightweight nineteen tube launchers can be mounted on any of the four wing stations. There are three modes of firing rockets: pilot, CPG, and cooperative (precision) mode. The FCC limits the fire control solution to a maximum range of 7000 meters (MK-40) and 9000 meters (MK-66).

c. **Point Target Weapons System.** The point target weapons system (figure 4-23), commonly called "Hellfire", is the primary armament on the helicopter for the destruction of tanks and other hard material targets. It provides the capability of firing missiles on the ground and airborne, at speeds from hover to the maximum level flight speed. The Hellfire currently has the tri-service type laser seeker. This gives the flight crew the capability of two types of launches: lock-on-before-launch (LOBL) and lock-on-after-launch (LOAL). The type depends only on when the laser designator is fired; before or after launch of the missile. The LOAL type of launch can specify three prelaunch programmed trajectories. The missiles can be launched in two types of modes: normal, sometimes referred to as rapid; and ripple. During normal mode only the priority channel missiles can be fired. During ripple mode priority and alternate channel missiles are fired alternately.

The copilot/gunner has the capability to launch missiles in all modes and types of engagements: RF ORIDE, NORM, RIPL, MAN, LOAL, or LOBL. The pilot has the capability to launch missiles in the following modes and types of engagements: RF ORIDE, NORM, LOAL, or LOBL. If the missile system is any mode other than normal, including STBY, when the pilot "ACTIONS" missiles, the missile system will automatically mode to NORM. The missile system prompts presented to the CPG are shown in either the sight status or weapons status section of the high action display. Autonomous designation missile launch prompts are shown in the weapons status section, remote designation missile launch prompts are shown in the sight status section. Autonomous designation is defined as when the missile code of the priority channel and the code of the LRF/D are the same and the selected sight is TADS plus the laser power is turned on. Remote designation is defined as when the missile code of the priority channel and the code of the LRF/D are not the same. Time of flight is displayed for all missile launches and reflects the time of flight for the missile closest to the target. Ripple fire

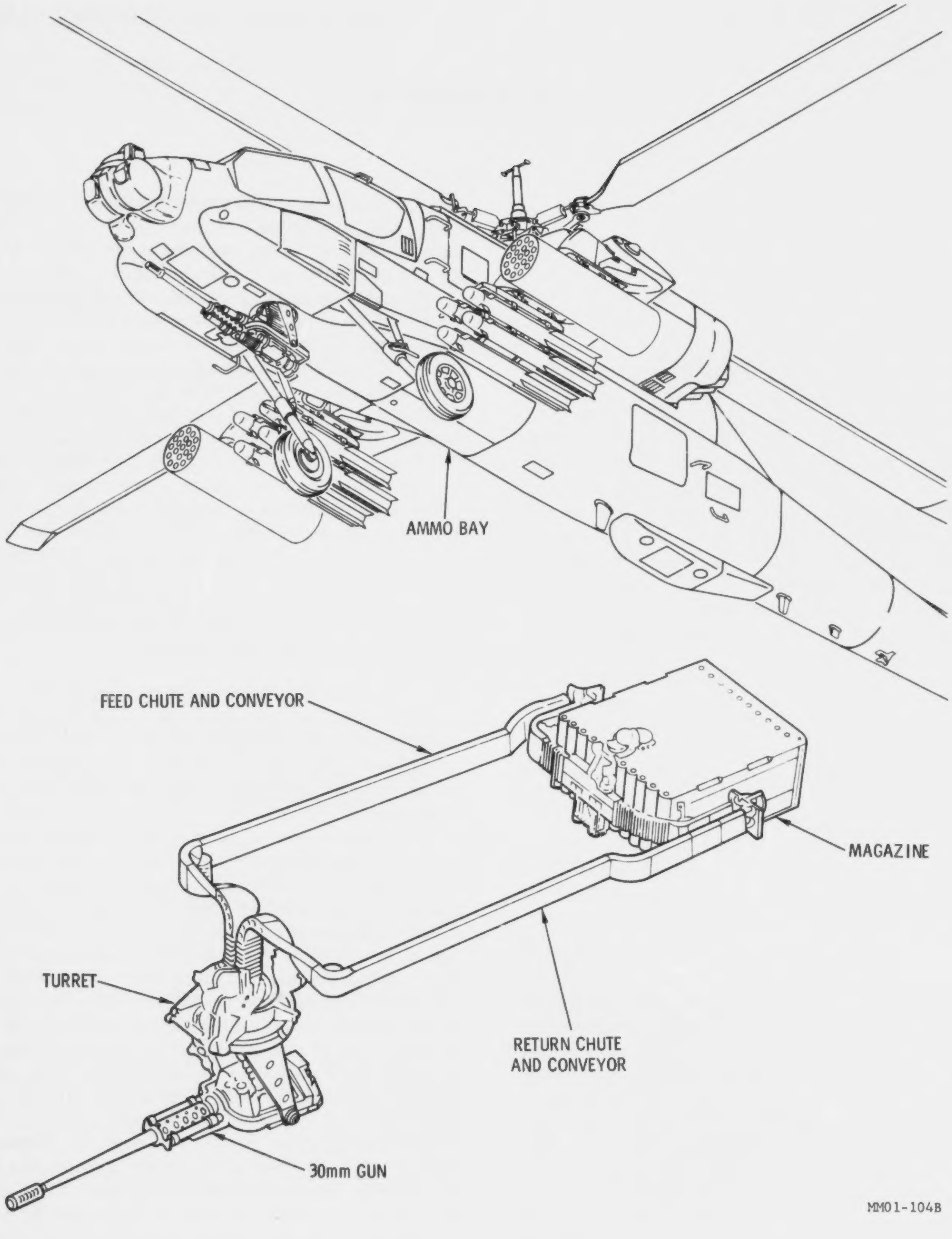
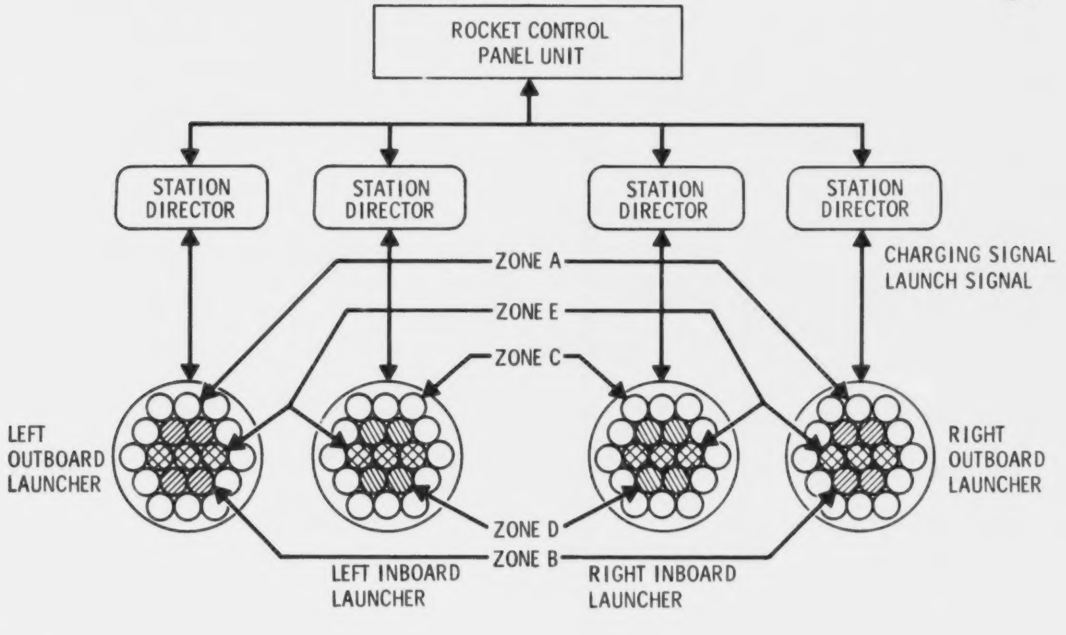

AMMO BAY
FEED CHUTE AND CONVEYOR
MAGAZINE
TURRET
RETURN CHUTE AND CONVEYOR
30mm GUN
MM01-104B

Figure 4-21. M-230E1, 30mm Area Weapon System


ROCKET CONTROL PANEL UNIT
STATION DIRECTOR
STATION DIRECTOR
STATION DIRECTOR
STATION DIRECTOR
CHARGING SIGNAL
LAUNCH SIGNAL
ZONE A
ZONE E
ZONE C
LEFT OUTBOARD LAUNCHER
RIGHT OUTBOARD LAUNCHER
ZONE D
ZONE B
LEFT INBOARD LAUNCHER
RIGHT INBOARD LAUNCHER

MM01-105D

Figure 4-22. Aerial Rocket (2.75 inch) Delivery System

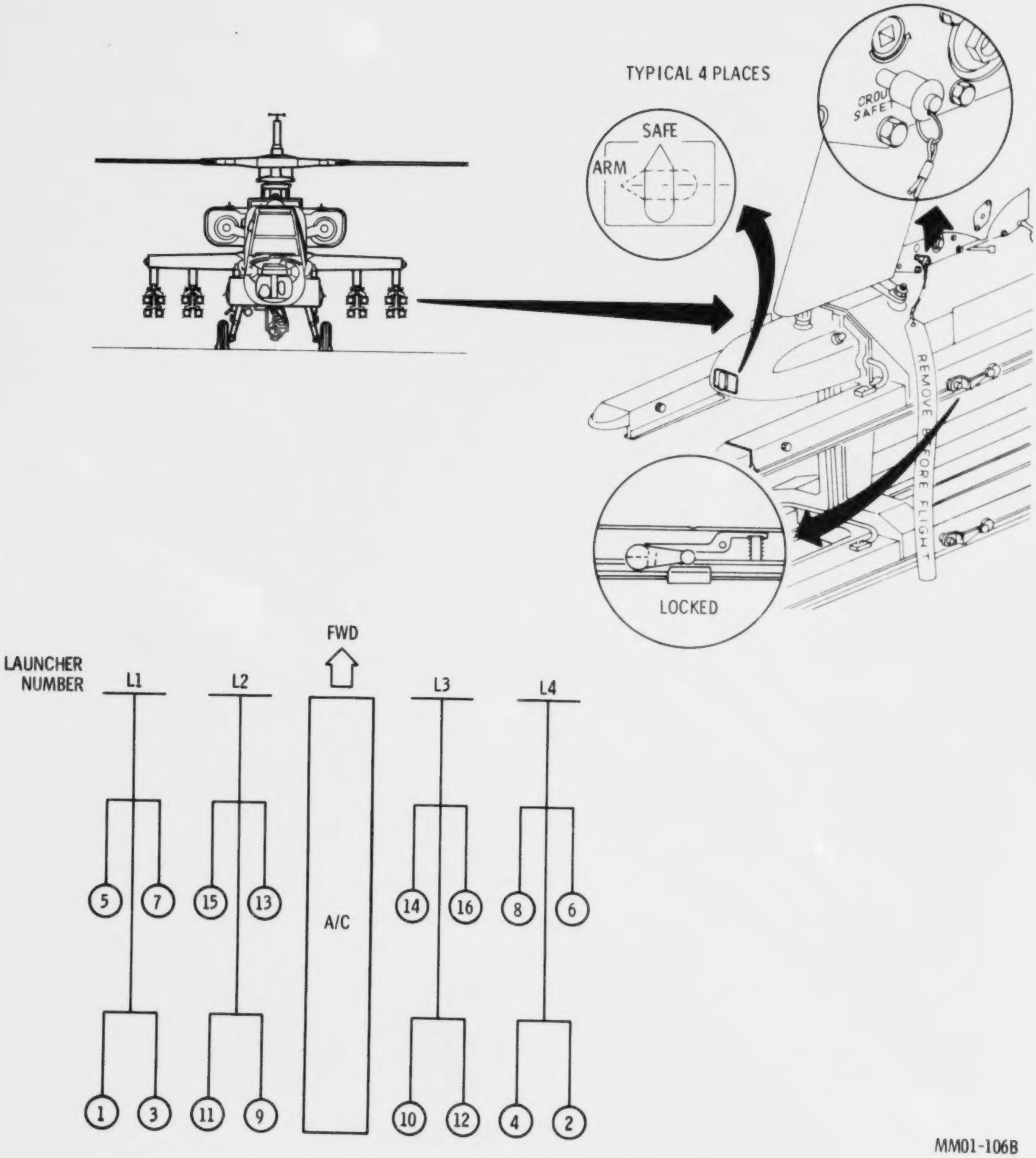

TYPICAL 4 PLACES
SAFE
ARM
CROU
SAFE
REMOVE BEFORE FLIGHT
LOCKED
FWD
LAUNCHER NUMBER
L1
L2
L3
L4
A/C
5
7
15
13
14
16
8
6
1
3
11
9
10
12
4
2
MM01-106B

Figure 4-23. Point Target (HELLFIRE) Preferred Missile Firing Order

engagements have individual time of flight counters displayed, one for the autonomous missile, and one for the remotely designated missile, regardless of the order of their launch. The pilot cannot launch missiles for autonomous designation; consequently only one set of prompts is displayed in the weapons status section of the high action display. Time of flight is displayed to the pilot for any missile that he has launched. The sight status section will reflect the codes of the upper and lower channels, UP = ALO = B; the code of the priority channel will flash. Authorized engagement ranges for the Hellfire System are from 500 meters to 8000 meters.

4-46. PREFLIGHT PROCEDURES.

NOTE

> Checks herein are only applicable if the armament is installed and are in addition to those listed in Chapter 8. Except for safety, Chapter 4 does not duplicate Chapter 8 checks.

4-47. Deleted.

4-48. IHADSS BORESIGHT – PILOT.

WARNING

OFFSET boresight not authorized.

1. VID SEL – GRAY SC.
2. Adjust brightness and contrast.
3. VID SEL – PLT.
4. SYM BRT – Adjust.
5. IHADSS BRSIT – ON.
6. INST lights – Adjust BRU intensity.
7. Align HMD reticle with BRU.
8. HMD BRSIT – Actuate then release.
9. IHADSS BRSIT – OFF.
10. INST lights – As desired.

4-48.1 FLIR Operational Check.

1. SIGHT SEL – NVS, check turret function.
2. Adjust gain and level for optimum image.
3. Verify capability to select the various modes of flight symbology.
4. Polarity reversal – Check.
5. Registration – Check.
    a. Align crewmembers LOS forward to the 12 o'clock position ± 5 degrees.
    b. Select a reference object approximately 90 feet in front of the aircraft.
    c. Check registration (alignment differential) between the thermal image and reference object (AZ and EL).
    d. The allowable registration error is 1 foot at 90 feet. The center open position of the LOS reticle is equivalent to 1 foot at 90 feet.
6. Alternate sensor – Check.

4-49. TADS OPERATIONAL CHECKS – CPG.

CAUTION

The FLIR zoom field-of-view should not be activated for more than two minutes of continuous operation in order to prevent raster retention. Permanent damage may occur if it is engaged for more than five minutes.

1. TADS – TADS or FLIR OFF, as desired.
2. GS – PRESS.
3. Adjust brightness and contrast as desired on heads-up and heads-down displays.
4. VID SEL – TADS.
5. SIGHT SEL – TADS.
6. Sensor Select – DTV
7. SLAVE – Actuate, turret should return to manual track.

8. Thumbforce controller – Exercise turret.
9. Field-of-view select – Evaluate various FOVs.
10. IAT / MAN – Engage image auto tracker and check for proper function.
11. Sensor Select – DVO.
12. Field-of-view select – Evaluate various FOVs. If scene is not vertical in both FOVs, perform Pechan Realignment, paragraph 4-49.1.
13. Sensor Select – FLIR.
14. Adjust gain and level for optimum image, then engage ACM, as desired.
15. Field-of-view select – Evaluate various FOVs.
16. IAT / MAN – Engage image auto tracker and check for proper performance.
17. Polarity reversal – Check, leave in white hot.
18. Sensor Select – DTV or FLIR.
19. Drift null – If Auto Drift Null does not reduce drift to desired level, perform Manual Drift Null, paragraph 4-49.2.

4-49.1 TADS PECHAN REALIGNMENT.

NOTE

This procedure realigns the voltages used to erect the Pechan (DVO) lens. It should be used in order to make the scene appear upright when viewing through the DVO. Should realignment be unsuccessful, refer to TM 9-1270-476-20.

1. Sensor select – DVO.
2. Field-of-View – N.
3. TADS turret – Manual control
4. BRSIT ENABLE – ON.
5. Left thumbwheel control – Adjust as required to align horizontal crosshair with horizon.
6. BRSIT ENABLE – OFF.
7. Field-of-View – W.
8. Recheck alignment of crosshair and horizon.
    a. If satisfactorily aligned procedure is complete. Select desired operating mode.:
    b. If not satisfactorily aligned :
        (1) BRSIT ENABLE – ON.
        (2) Adjust right thumbwheel control as required to align horizontal crosshair with horizon.
        (3) BRSIT ENABLE – OFF.
        (4) Field-of-View – N.
        (5) Reverify alignment of NFOV. If satisfactory, procedure is complete. If unsatisfactory, repeat steps 4 through 8 above as required. If still unsatisfactory, see note above.

4-49.2 TADS MANUAL DRIFT NULL.

1. SLAVE switch – Press and verify dotted crosshair is present on selected display (HOD or HDD).
2. SIGHT SEL – TADS
3. Verify TADS turret slews to fixed forward position by observing solid crosshair coming to center of display and cueing LOS centering on cueing dot.
4. SLAVE SWITCH – PRESS.
5. Sensor select switch – TV or FLIR. For greatest accuracy, use TV.
6. Field-of-View – N.
7. Aim reticle at an easily observed object.
8. BRSIT ENABLE switch – Up position, wait 5 seconds then adjust left and right thumbwheel controls for drift null.
9. BRSIT ENABLE switch – Center position.

4-50. IHADSS BORESIGHT – CPG.

WARNING

OFFSET Boresight not authorized.

1. SIGHT SEL – HMD, HMD TADS, or NVS.
2. GS – Press.
3. Adjust brightness and contrast.
4. VID SEL – TADS.
5. SYM BRT – Adjust.
6. BRSIT IHADSS – ON.
7. INST lights – Adjust BRU intensity.
8. Align HMD reticle with BRU.
9. HMD BRSIT – Actuate, then release.
10. BRSIT IHADSS – OFF.
11. INST lights – As desired.

4-50.1 Deleted.

4-51. TADS BORESIGHT.

WARNING

Proper laser safety procedures shall be followed.

NOTE

Boresighting of the DTV and FLIR narrow and zoom fields-of-view occurs independently; the actual order is not critical. The order shown is only recommended. However, in each sensor, DTV and FLIR, the NFOV must be boresighted prior to boresighting the ZFOV.

A. CUE Update Procedure

NOTE

The CUE update procedure should be accomplished whenever the TADS FLIR is reported as being unable to be internally boresighted. Once the CUE update procedure has been accomplished and the TADS FLIR still cannot be boresighted, continue with troubleshooting as specified in TM 9-1270-476-20.

1. SIGHT SEL switch – TADS.
2. Sensor Select switch – DTV.
3. Field-of-View Select switch – W.
4. BRSIT – TADS.
5. SLAVE switch – Actuate. Verify internal boresight message replaced by cue update message.
6. If reticle does not appear centered on the black cross, execute the following:
   a. BRSIT ENABLE – UP.
   b. Use thumbforce controller to position DTV reticle in proximity to the black cross.
   c. BRSIT ENABLE – Center.
   d. SLAVE switch – Actuate. Verify cue update message replaced by internal boresight message.
   e. BRSIT TADS – OFF. Procedure complete, continue as desired.

B. TADS Internal Boresight.

1. DTV
   a. PLT / GND ORIDE – As required.
   b. CPG ARM – ARM.

c. SIGHT SEL – TADS.

d. BRSIT – TADS. Confirm "Internal Boresight" message is present.

e. LSR Switch – ON.

f. Sensor Select – DTV.

g. Field-of-View Select – N.

h. Tracker polarity white over black.

i. Laser trigger – Press.

j. BRSIT ENABLE – UP position, observe tracking gates capture laser spot. Continue to fire laser until tracking gates disappear. If spot cannot be captured by tracking gates, perform manual boresight adjustment, paragraph 4-51.D.

k. BRSIT ENABLE – Center position.

l. Laser trigger – Release.

m. Field-of-View Select – Z.

n. Repeat steps h through k.

2. FLIR

a. Sensor Select – FLIR.

b. Field-of-View Select – N.

c. Adjust FLIR level fully counterclockwise.

d. Adjust FLIR gain mid-range.

e. Laser trigger – Press.

f. Observe laser spot, and optimize FLIR. If laser spot is not visible, perform CUE Update Procedure, paragraph 4-51.A.

g. BRSIT ENABLE – UP position, observe tracking gates capture laser spot. Continue to fire the laser until tracking gates disappear. If spot cannot be captured by tracking gates, perform manual boresight adjustment, paragraph 4-51.D.

h. BRSIT ENABLE – Center position.

i. Laser trigger – Release.

CAUTION

The FLIR zoom FOV shall not be activated for more than 2 minutes of continuous operation in order to prevent excessive raster retention. Permanent damage may occur if it is engaged for more than 5 minutes continuously.

j. Field-of-View Select – Z.

k. Repeat steps f through i.

l. LSR – OFF.

m. CPG ARM – SAFE.

3. DVO

a. Sensor Select – DVO.

b. Field-of-View Select – N.

c. Observe position of DVO crosshairs; if coincident with DTV reticle, go to step g, below.

d. BRSIT ENABLE – DOWN position.

e. DVO BRSIT – Adjust DVO crosshairs into coincidence with DTV reticle.

f. BRSIT ENABLE – Center position.

g. BRSIT – OFF.

h. ACQ SEL – FXD.

i. Slave switch – Press, TADS returns to the fixed forward position.

C. TADS Outfront Boresight.

WARNING

TADS Outfront Boresight validation and adjustment (if necessary) shall be performed prior to using the TADS FLIR imagery for laser or weapons operations.

1. Position helicopter, on the ground, over identified location for this procedure.
2. If on an approved laser firing range, fire laser to obtain range. Otherwise, enter, manually, the range from helicopter to the outfront boresight target.

NOTE

If the target is between 0.5 km and 1.5 km, the range entered on the DEK must be within 10 meters. If the target is between 1.5 km and 5 km, the range entered on the DEK must be within 50 meters. If the target is greater than 5 km, the range entered on the DEK must be within 1 km.

3. Observe the outfront boresight target in NFOV FLIR, adjust gain and level for optimum autotracker image. Engage IAT.
4. Sensor Select – DTV, observe light source.
5. If not precisely centered on the TADS reticle, execute the following.
6. BRSIT TADS – TADS. Confirm message, "Outfront ..... Boresight" is present.
7. BRSIT ENABLE – UP.
8. Adjust AZ and EL pots to center the target on the reticle.
9. BRSIT ENABLE – Center.
10. IAT – OFF.
11. BRSIT TADS – OFF.

D. Manual Boresight Adjust.

NOTE

The manual boresight procedure is used only to recapture or center the laser spot. It is not an acceptable boresight procedure for normal flight operations.

1. BRSIT TADS – TADS. Confirm message, "Internal .... Boresight" is present.
2. LSR select switch – ON.
3. Sensor select switch – FLIR.
4. FLIR PLRT – Press to select white hot.
5. Field-of-View – N.
6. Gain – Midrange.
7. LVL – Fully counterclockwise.
8. Laser trigger – Press.
9. Observe laser spot and optimize FLIR.
10. BRSIT ENABLE – UP for 1 second, then move to center position. After 5 seconds, the left and right thumbwheel controls will be active and the laser spot can be adjusted in elevation and azimuth.
11. Laser TRIG – Release.
12. LSR switch – Off.

4-52. RAPID REARMING.

1. TAIL WHEEL switch - LOCK.
2. PARK BK - Set.
3. Weapons SEL switches - OFF.
4. MASTER/CPG ARM/SAFE - OFF.
5. PLT/GND ORIDE - OFF.
6. HARS switch - NORM.
7. Armament and pylon safety pins - Installed.
8. Monitor rearming.
9. Armament and pylon safety pins - Removed.
10. Perform before - takeoff check.

4-53. Deleted.

4-54. M-230E1, 30mm GUN SYSTEM - INFLIGHT PROCEDURES.

WARNING

If 300 or more rounds have been fired in the preceding ten minutes, and a stoppage occurs, personnel must remain clear of the aircraft for 30 minutes. Aircraft crewmembers should remain in the aircraft and continue positive gun control.

CAUTION

Limit actual dry firing of the M230E1 Armament Subsystem to Maintenance Operation Checks and Procedures due to the extreme wear of the Ammunition Carrier System.

1. Master/CPG ARM - ARM.
2. Gun select switch - As desired.
3. Crew member desiring to fire - Establish range to target and track target with selected sight.
4. WAS - GUN.
5. WEAPONS trigger - Press, continue to fire as required.
6. WAS - Deselect gun.

4-55. AERIAL ROCKET CONTROL AND DELIVERY SYSTEM - INFLIGHT PROCEDURES.

1. **CPG Cooperative Engagement Mode.**
   a. CPG switch - ARM.
   b. Rocket select switch - As desired.
   c. Desired target - Acquire and track.
   d. ORT WAS - RKT.
   e. Laser trigger - Press, establish range aircraft to target.
   f. On completion of engagement: ORT WAS - Center position.
2. **Pilot Cooperative Engagement Mode.**
   a. MASTER switch - ARM.
   b. Rocket select switch - As desired.
   c. Rockets control panel - Set: quantity, PEN-M; zone select.
   d. WAS - RKT.
   e. Align rocket steering symbology.
   f. WEAPONS trigger - Press, until selected quantity has been fired or target neutralized.
   g. WAS - Deselect rockets.
3. **Pilot or CPG Only Mode.**
   a. MASTER/CPG ARM/SAFE - ARM.
   b. Rocket select switch - As desired.
   c. Rockets control panel - Pilot set: quantity, PEN-M; zone select.
   d. Crew member desiring to fire - Track target with HMD, maintaining LOS reticle on the target. Establish range.
   e. WAS - RKT.
   f. Align rocket steering symbology.

g. WEAPONS trigger - Press until selected quantity has been fired or target neutralized.

h. WAS - Deselect rockets.

4-56. POINT TARGET WEAPONS SYSTEM - IN FLIGHT PROCEDURES.

1. MSL SEL - ON, observe "BIT IN PROGRESS" message on high action display and AND. When message disappears any failed BIT status will be displayed on AND.

NOTE

If BIT failure indicates MSL failure, and that missile is required to complete the mission, another BIT cycle may be initiated. If additional BIT indicates a go, then missile is considered functional and may be launched. If missile fails second Built-In-Test (BIT) then missile shall be rejected.

NOTE

BIT may be overridden at any time by placing the missile mode switch in any mode other than STBY.

2. TYPES OF ENGAGEMENTS.

a. NORMAL MODE - LOBL.

(1) UPR/LWR CHAN CODE - As desired.

(2) UPR/LWR CHAN QTY - As desired.

(3) MSL MODE - NORM.

(4) CHAN SEL - Establish priority channel.

(5) Observe AND for missile selection, coding, and ready status.

(6) Lase target or call for remote designator.

(7) Observe AND or HIGH ACTION display for proper missile track status.

(8) MASTER/CPG ARM/ SAFE - ARM.

(9) ORT WAS - MSL.

(10) Pilot establish helicopter in constraints.

(11) WEAPONS Trigger - Press and release.

NOTE

If "in constraints" criteria are not met, the 2nd detent of the weapons trigger may be used to override constraints inhibits and fire missile.

(12) If autonomously designating, continue lasing until missile impact.

b. NORMAL MODE - LOAL.

(1) UPR/LWR CHAN CODE - As desired.

(2) UPR/LWR CHAN QTY - As desired.

(3) MSL Mode - NORM.

(4) CHAN SEL - Establish priority channel.

(5) Observe AND or HIGH ACTION display for missile selection, coding, and ready status.

(6) LOAL - As desired.

(7) MASTER/CPG ARM/ SAFE - ARM.

(8) WAS - MSL.

(9) Pilot establish helicopter in constraints.

(10) WEAPONS trigger - Press and release.

(11) Lase target or call for remote designator in adequate time for terminal guidance.

c. RIPPLE MODE - LOBL.

(1) UPR/LWR CHAN CODE - As desired.

(2) UPR/LWR CHAN QTY - As desired.

(3) MSL mode - RIPL.

(4) CHAN SEL - Establish priority channel.

(5) Observe AND for missile selection, coding, and ready status.

(6) Lase target or call for remote designator.

(7) Observe AND or HIGH ACTION display for missile system messages.

(8) MASTER/CPG ARM/
SAFE - ARM.

(9) WAS - MSL.

(10) Pilot establish the helicopter in constraints.

(11) WEAPONS trigger - Press and release.

(12) Pilot establish helicopter in constraints.

(13) Repeat steps 10 thru 12 until desired number of missiles have been fired.

d. RIPPLE MODE - LOAL.

(1) UPR/LWR CHAN CODE - As desired.

(2) UPR/LWR CHAN QTY - As desired.

(3) MSL mode - RIPL.

(4) CHAN SEL - Establish priority channel.

(5) Observe AND or HIGH ACTION display for missile selection, coding, ready status.

(6) LOAL - As desired.

(7) MASTER/CPG ARM/
SAFE - ARM.

(8) WAS - MSL.

(9) Pilot establish helicopter in constraints.

(10) Weapons trigger - Press and release.

(11) Pilot establish helicopter in constraints for alternate channel.

(12) Weapons trigger - Press and release.

(13) Lase target or call for terminal guidance.

(14) Execute steps 9 thru 13 until desired number of missiles have been fired.

e. MISSILE SYSTEM SHUTDOWN PROCEDURES.

(1) MSL Mode - STBY.

(2) LOAL - OFF.

(3) CHAN SEL - Actuate
either direction.

(4) MSL SEL - OFF.

4-57. WAYPOINT / TARGETING PROCEDURES.

Waypoint/targeting functions are performed solely by the CPG. The pilot cannot actively participate. Four functions can be implemented. These are: preflight, storing, position update, and cueing.

4-58. WAYPOINT / TARGETING - DATA ENTRY.

a. The waypoint / targeting function requires certain data. The data is input using both the TRGT and SP1 positions on the DEK rotary switch. The data entered under SP1 is displayed as a menu with two pages. They are:

```
TIME:     HH: MM: SS
PPOS:     11S  QG  5551  5221
ALT:      +AAAA'  HG: 29.92IN.
```

```
SPH:CL6   MV:         E013.8 DEG
GRID CONVERG:         E01.48 DEG
HEADING (MAG):        000.0  DEG
```

b. To enter data: Input the first character of the desired parameter. The cursor will jump to the first digit position of the data, then input the full data required. On completion the data will be automatically entered.

c. The FCC present position (PPOS) data are used only for the initial alignment of the HARS when the helicopter is on the ground. The present position shall be entered prior to a normal or fast alinement of the HARS. It is not required for a stored heading alinement or inflight restart. The accuracy of the present position input should be within 500 - 750 meters, straight line distance, from the actual location. Inflight this display will periodically update reflecting the doppler present position. The doppler display updates at a substantially higher rate than the PPOS display, consequently there may not be any correlation of the doppler and PPOS display in forward flight. This is normal and does not indicate a problem condition. If at any time ?? appear following the PPOS data, as shown in the example, the FCC is rejecting the doppler navigation data as being in error. This may be an indication of doppler malfunction or that the doppler has not been updated recently. The displayed PPOS data, in this case, will then reflect the best computed present position based on HARS velocity data.

d. The altitude and altimeter setting data are to be used in the following manner: Altitude above mean sea level shall be entered when the aircraft is on the ground. The value is determined from referring to navigational charts or by tactical map study. The Fire Control System will compute the corresponding altimeter setting. The altimeter setting shall be entered when the aircraft is inflight. The altitude display may be observed inflight; if an error exists in the dynamic altitude display when compared to the aircraft barometric altimeter, the altimeter setting should be entered. The altimeter setting can normally be obtained from a local air traffic control agency. In the event of a failure of the air data sensor, question marks, ??.??, will be displayed in the altimeter setting display. The fire control system will attempt to derive the aircraft altitude above mean sea level by adding radar altitude to the last valid altitude value displayed. The altitude value should then be periodically updated inflight. The altitude value computed from radar altitude is accomplished based on a standard atmosphere.

e. The TIME display functions only when power is applied to the fire control computer. The TIME display is not part of the backup bus controller software. The TIME display will increment from whatever time value is entered; on initial power up the TIME value is zero. If a TIME value of 00:00:00 is input the TIME display will function as an elapsed time clock. The TIME display is a twenty-four hour clock with an accuracy of plus or minus 1 second while running.

f. Conventions used are:

(1) Magnetic variation - use E for East and W for West, as appropriate.

(2) Grid Convergence - Use E for East and W for West, as appropriate. Data may be obtained from G-M angle diagram on UTM maps if applicable.

(3) Spheroid - use the same codes utilized by the doppler.

(4) Latitude - Use N for North and S for South, as appropriate.

4-59. WAYPOINT / TARGETING COORDINATE DATA – STORING.

a. Up to ten sets of coordinate data may be stored in the FCC at any time. Two methods can be used to store coordinate data; these are either the data entry keyboard, or by use of the STORE position of the UPDT/ST switch on the ORT LHG.

b. The coordinate data are displayed as four pages of a coordinate data menu. The various pages may be paged by using the SPACE key on the DEK. An example page is shown below:

```
                          TRGT
0  11S  QG51285172  A + 0820'
1  NO  DATA
2  NO  DATA
```

c. To enter data: Input the appropriate coordinate data address. The cursor will jump to the first position for data entry, i.e., grid zone. Either input the specific grid zone or use the SPACE key for automatic entry if the coordinate data grid zone is the same as the aircraft's current present position. Then cursor will advance to the first position of the 100 KM ID; either input the data or use the SPACE key followed by the eight or six-digit coordinates. Pressing the SPACE key will automatically enter the 'A' for the altitude. If the altitude of the coordinate data is above sea level directly input the numbers; if necessary a leading zero is required. The plus sign will be automatically entered; if coordinate data is below sea level the minus sign must be input prior to the numeric value.

d. If a particular storage location has no data the message NO DATA will be shown. If it is desired to clear a specific storage location, key in the letter 'C' followed by the desired coordinate data storage location address. The location will be cleared and the message NO DATA will be displayed.

e. **Storing Coordinate Data Via the STORE Switch.**

f. Waypoint/target index – Desired storage location.

g. Enter range, aircraft to waypoint/ target.

NOTE

Range to geographic feature or object must be input to the FCC. This may be accomplished by three means: 1. Manual range input through the keyboard (determined from a map or by estimation); 2. Automatically calculated range based on LOS angles from selected sight; 3. Laser range input by firing the laser after placing reticle on feature or object (This is the most accurate range data).

h. Place reticle of selected sight on the geographic feature or object.

i. UPDT/ST – ST. (Waypoint/target coordinate data will be automatically calculated and placed in the location specified by the index.)

4-60. POSITION UPDATE.

NOTE

This subsystem of waypoint/targeting calculates the present position of the helicopter based on previously stored coordinate data. The updated present position is stored within the FCC and NOT automatically sent to the doppler navigation system.

1. **Position Update.**

a. Waypoint/target indexer – index of location of previously stored coordinate data.

b. Enter range, helicopter to coordinate data. See explanation under storing coordinate data (para 2b).

c. Place reticle of selected sight on the geographic feature or object of previously entered coordinate data.

d. UPDT/ST – UPDT. (The aircraft present position is calculated automatically, based on the previously entered coordinate data.)

2. **To Recall the Updated Helicopter Present Position.**

a. Data entry keyboard – SP1.

b. Input – U (The updated present position data is automatically displayed).

3. **To Update the Doppler.**

a. Recall updated aircraft present position immediately after accomplishing update function.

b. Insert the FCC displayed present position into the doppler using normal procedures.

4. **Example of Updated Present Position Data.**

a. Input – U.

b. Display After Entering: UPDATE.

A/C 11S QG56035160

DELEAS = +0065

DELNOR = -0012

c. Which decodes as follows:

Grid Zone – 11S

Coordinates – QG56035160

Doppler easting error – +65 meters

Doppler northing error – 12 meters

d. If the coordinates updated from had not been previously stored, an attempt to recall the updated present position will result in a "NO DATA" message on the display.

4-61. CUEING.

Once waypoint/target data has been stored, sightline cueing or TADS slaving to the stored coordinates can be accomplished as follows:

1. **Sightline Cueing or TADS Slaving.**

a. Waypoint/target indexer – Index of desired coordinate data.

b. Acquisition Select – TGT or NAV.

c. Slave button – Press.

d. If the selected sight was TADS, TADS will be slaved so as to place its LOS reticle over the geographic feature or object on the ground.

e. If the selected sight was other than TADS, the CPG will be cued in the normal manner so as to cue the CPG to place the reticle of his selected sight over the geographic feature or object.

2. **To Recall Range and Bearing, Helicopter Present Position to Stored Coordinate Data.**

a. Data entry keyboard – TRGT.

b. Input – Rn. (Where n = coordinate data storage address.)

3. **Example:**

a. Input – R3.

b. After entering, display shows – 3R 15990 B042.4 degrees.

c. Which decodes as follows:

Waypoint/target storage (index) No. – 3.

Range, helicopter to coordinate data – 15990 meters.

Bearing, helicopter to coordinate data – 042.4 degrees.

d. If no previously stored coordinate data exists in the index location selected, a message "NO DATA" will be displayed.

e. The range and bearing function can be accomplished at any time after storing waypoint/target data.

f. Maximum possible displayed range for this function is 32000 meters.

4-62. Deleted.

d. The altitude and altimeter setting data are to be used in the following manner: Altitude above mean sea level shall be entered when the aircraft is on the ground. The value is determined from referring to navigational charts or by tactical map study. The Fire Control System will compute the corresponding altimeter setting. The altimeter setting shall be entered when the aircraft is inflight. The altitude display may be observed inflight; if an error exists in the dynamic altitude display when compared to the aircraft barometric altimeter, the altimeter setting should be entered. The altimeter setting can normally be obtained from a local air traffic control agency. In the event of a failure of the air data sensor, question marks, ??.?? will be displayed in the altimeter setting display. The fire control system will attempt to derive the aircraft altitude above mean sea level by adding radar altitude to the last valid altitude value displayed. The altitude value should then be periodically updated inflight. The altitude value computed from radar altitude is accomplished based on a standard atmosphere.

e. The TIME display functions only when power is applied to the fire control computer. The TIME display is not part of the backup bus controller software. The TIME display will increment from whatever time value is entered; on initial power up the TIME value is zero. If a TIME value of 00:00:00 is input the TIME display will function as an elapsed time clock. The TIME display is a twenty-four hour clock with an accuracy of plus or minus 1 second while running.

f. Conventions used are:

(1) Magnetic variation – use E for East and W for West, as appropriate.

(2) Grid Convergence – Use E for East and W for West, as appropriate. Data may be obtained from G-M angle diagram on UTM maps.

(3) Spheroid – use the same codes utilized by the AN/ASN-128 DSN.

(4) Latitude – use N for North and S for South, as appropriate.

4-59. WAYPOINT / TARGETING COORDINATE DATA – STORING.

a. Up to ten sets of coordinate data may be stored in the FCC at any time. Two methods can be used to store coordinate data; these are either the data entry keyboard, or by use of the STORE position of the UPDT/ST switch on the ORT LHG.

b. The coordinate data are displayed as four pages of a coordinate data menu. The various pages may be paged by using the SPACE key on the DEK. An example page is shown below:

```
                              TRGT
0  11S  QG51285172  A+0820'
1  NO  DATA
2  NO  DATA
```

c. To enter data: Input the appropriate coordinate data address. The cursor will jump to the first position for data entry, i.e., grid zone. Either input the specific grid zone or use the SPACE key for automatic entry if the coordinate data grid zone is the same as the aircraft's current present position. Then cursor will advance to the first position of the 100 KM ID; either input the data or use the SPACE key followed by the eight or six digit coordinates. Pressing the SPACE key will automatically enter the 'A' for the altitude. If the altitude of the coordinate data is above sea level directly input the numbers; if necessary a leading zero is required. The plus sign will be automatically entered; if coordinate data is below sea level the minus sign must be input prior to the numeric value.

d. If a particular storage location has no data the message NO DATA will be shown. If it is desired to clear a specific storage location, key in the letter 'C' followed by the desired coordinate data storage location address. The location will be cleared and the message NO DATA will be displayed.

2. Storing Coordinate Data Via the STORE Switch.

a. Waypoint/target index – Desired storage location.

b. Enter range, aircraft to waypoint/target.

NOTE

Range to geographic feature or object must be input to the FCC. This may be accomplished by three means: 1. Manual range input through the keyboard (determined from a map or by estimation); 2. Automatically calculated range based on LOS angles from selected sight; 3. Laser range input by firing the laser after placing reticle on feature or object (This is the most accurate range data)

c. Place reticle of selected sight on the geographic feature or object

d. UPDT/ST – ST (Waypoint/target coordinate data will be automatically calculated and placed in the location specified by the index.)

4-60. POSITION UPDATE.

NOTE

This subsystem of waypoint/targeting calculates the present position of the helicopter based on previously stored coordinate data. The updated present position is stored within the FCC and NOT automatically sent to the AN/ASN-128 doppler navigation system.

1. Position Update.

a. Waypoint/target indexer – index of location of previously stored coordinate data.

b. Enter range, helicopter to coordinate data. See explanation under storing coordinate data (para 2b).

c. Place reticle of selected sight on the geographic feature or object of previously stored coordinate data.

d. UPDT/ST – UPDT. (The aircraft present position is calculated automatically, based on the previously stored coordinate data.)

2. To Recall the Updated Helicopter Present Position.

a. Data entry keyboard – SP1.

b. Input – U (The updated present position data is automatically displayed).

3. To Update the AN/ASN-128 Doppler.

a. Recall updated aircraft present position immediately after accomplishing update function.

b. Insert the FCC displayed present position into the doppler using normal procedures.

4. Example of Updated Present Position Data.

a. Input – U.

b. Display After Entering: UPDATE.

A/C 11S QG56035160

DELEAS = +0065

DELNOR = -0012

c. Which decodes as follows:

Grid Zone – 11S

Coordinates – QG56035160

Doppler easting error – +65 meters

Doppler northing error – 12 meters

d. If the index location entered was not the same as the index location updated from, the display will show an "ERROR" message.

e. If the coordinates updated from had not been previously stored, an attempt to recall the updated present position will result in a "NO DATA" message on the display.

4-61. CUEING.

Once waypoint/target data has been stored, sightline cueing or TADS slaving to the stored coordinates, can be accomplished as follows:

1. **Sightline Cueing or TADS Slaving.**

a. Waypoint/target indexer - Index of desired coordinate data.

b. Acquisition Select - TGT or NAV.

c. Slave button - Press.

d. If the selected sight was TADS, TADS will be slaved so as to place its LOS reticle over the geographic feature or object on the ground.

e. If the selected sight was other than TADS, the CPG will be cued in the normal manner so as to cue the CPG to place the reticle of his selected sight over the geographic feature or object.

2. **To Recall Range and Bearing, Helicopter Present Position to Stored Coordinate Data.**

a. Data entry keyboard - TRGT.

b. Input - Rn. (Where n = coordinate data storage address.)

3. **Example:**

a. Input - R3.

b. After entering, display shows - 3R 15990 B042.4 degrees.

c. Which decodes as follows:

Waypoint/target storage (index) No. - 3.

Range, helicopter to coordinate data - 15990 meters.
Bearing, helicopter to coordinate data - 042.4 degrees.

d. If no previously stored coordinate data exists in the index location selected, a message "NO DATA" will be displayed.

e. The range and bearing function can be accomplished at any time after storing waypoint/target data.

f. Maximum possible displayed range for this function is 32000 meters.

4-62. BEFORE LANDING CHECK - Deleted.

CHAPTER 5

OPERATING LIMITS AND RESTRICTIONS

Section I. GENERAL

5-1. PURPOSE.

This chapter identifies, or refers to, all important operating limits and restrictions that shall be observed during ground and flight operations.

5-2. GENERAL.

The operating limitations set forth in this chapter are the direct results of design analysis, test, and operating experiences. Compliance with these limits will allow the pilot to safely perform the assigned missions and to derive maximum utility from the aircraft.

5-3. Exceeding Operational Limits.

Any time an operational limit is exceeded, an appropriate entry shall be made on DA Form 2408-13. Entry shall state what limit or limits were exceeded, range, time beyond limits, and any additional data that would aid maintenance personnel in the maintenance action that may be required.

5-4. Minimum Crew Requirements.

The minimum crew required to fly the helicopter is a pilot and a copilot. A technical observer may be authorized to occupy the CPG station during test flights on a case by case basis at the discretion of the commander

Section II. SYSTEM LIMITS

5-5. INSTRUMENT MARKINGS ILLUSTRATIONS.

5-6. Instrument Marking Color Code.

Operating limitations and ranges are illustrated by colors on the engine, flight, and utility system instruments. RED markings indicate the limit above or below which continued operation is likely to cause damage or shorten component life. GREEN markings indicate the safe or normal range of operation. YELLOW markings indicate the range when special attention should be given to that operation covered by the instrument. Operation is permissible in the yellow range, but may be time limited or cautionary. Scales with green-coded, yellow-coded, or red-coded segments above green-coded segments operate in this manner: the segment will light in normal progression and remain on as the received signal level increases. Those segments will go off in normal progression as the received signal level decreases. Scales with red-coded and/or yellow-coded segments below green-coded segments operate in this manner: when the received signal level is zero or bottom scale, the segments will light in normal progression and will remain on. When the first segment above the red or yellow range goes on, all red-coded or yellow-coded segments will go off. These segments will remain off until the received signal level indicates a reading at or within the red or yellow range. At that time all red-coded or yellow-coded segments will go on and the scale display will either go on or off in normal progression, depending upon the received signal level. Blue colored segments indicate that power is on.

5-7. Rotor Limitations.

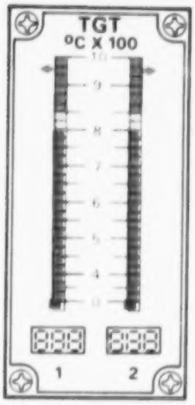
It is not abnormal to observe a % RPM 1 and 2 speed split during autorotation descent when the engines are fully decoupled from the transmission. A speed increase from 100 percent reference to 104 percent maximum is possible. Refer to figure 5-1 for limitations.

5-8. Rotor Start and Stop Limits.

Maximum wind velocity for rotor start or stop is 45 knots.

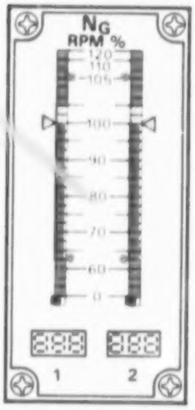
5-9. Rotor Speed Limitations.

Refer to figure 5-1 for rotor limitations.



ENGINE TURBINE GAS TEMPERATURE (TGT) (°C x 100)

		LIMITS	
RED	◆	965	MAXIMUM
RED	🟥	917-965	TRANSIENT 12 SECOND MAXIMUM
RED	🟥	867-917	CONTINGENCY (2.5 MINUTE LIMIT)
RED	🟥	867	MAXIMUM DURING START
YELLOW	🟨	805-867	INTERMEDIATE RATED POWER (30 MINUTE LIMIT)
GREEN	🟩	805	MAXIMUM CONTINUOUS POWER
GREEN	🟩	0-805	NORMAL OPERATION
BLUE	🟦		INSTRUMENT POWER ON

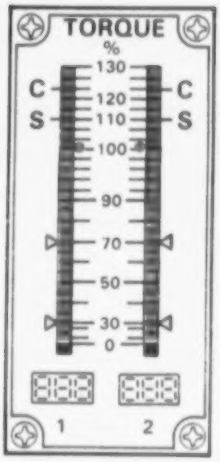


ENGINE GAS GENERATOR SPEED (N_G) (RPM%)

			LIMITS	
RED	🟥	(UPPER)	102-105	TRANSIENT 12 SECOND MAXIMUM
YELLOW	🟨		99-102	30 MINUTE LIMIT
GREEN	🟩		63-99	NORMAL OPERATION
RED	🟥	(LOWER)	63	MINIMUM-ENGINE OUT WARNING LIGHT SET AT THIS VALUE
BLUE	🟦			INSTRUMENT POWER ON
RED	●			BEGINNING OF A RED RANGE (FROM A NORMAL OPERATING REFERENCE)
YELLOW	▷			BEGINNING OF A YELLOW RANGE (FROM A NORMAL OPERATING RANGE)

1291-131-1D

Figure 5-1. Instrument Markings (Sheet 1 of 6)

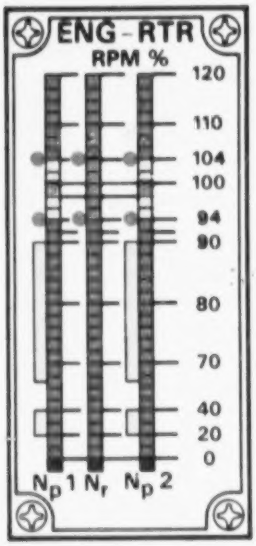


TORQUE (%)

RED	●		BEGINNING OF A RED RANGE (FROM A NORMAL OPERATING REFERENCE)
RED	🟥	122-125	SINGLE ENGINE TRANSIENT (6 SECOND LIMIT)
WHITE	C	122	SINGLE ENGINE CONTINGENCY POWER (2.5 MINUTE LIMIT)
RED	🟥	100-115	DUAL ENGINE TRANSIENT (6 SECOND LIMIT)
WHITE	S	110	SINGLE ENGINE MAXIMUM CONTINUOUS POWER
GREEN	🟩	0-100	DUAL ENGINE NORMAL OPERATION
YELLOW	▷	30	DO NOT EXCEED WITH LESS THAN 50% Nr
YELLOW	▷	70	DO NOT EXCEED WITH LESS THAN 90% Nr
BLUE	🟦		INSTRUMENT POWER ON

1M01-131-2D

Figure 5-1. Instrument Markings (Sheet 2 of 6)



NOTE

- DO NOT HESITATE WHEN TRANSITIONING THRU AREAS MARKED WITH YELLOW BAND
- TRANSIENT OPERATIONS UP TO 110% Np ARE AUTHORIZED WITH MAXIMUM OF 6 SECONDS ABOVE 104% Np.

ENGINE POWER TURBINE SPEED [Np] [RPM%]

LIMITS

RED	■	(UPPER)	104	MAXIMUM
YELLOW	☐	(UPPER)	100-104	TRANSIENT OPERATION ONLY
GREEN	■	(UPPER)	98-100	NORMAL OPERATION
YELLOW	☐	(LOWER)	94-98	TRANSIENT OPERATION ONLY
RED	■	(LOWER)	94	MINIMUM ENGINE OUT WARNING LIGHT SET AT THIS VALUE

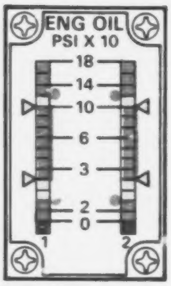
ROTOR SPEED [NR] [RPM%]

LIMITS

RED	■		104-110	TRANSIENT OPERATION
GREEN	▨		94-104	NORMAL OPERATION
RED	■	(LOWER)	0-94	TRANSIENT POWER OFF
BLUE	■			INSTRUMENT POWER ON
RED	●			BEGINNING OF RED RANGE (FROM A NORMAL OPERATING REFERENCE)

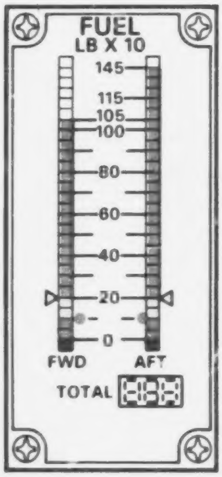
MM01-131-3G

Figure 5-1. Instrument Markings (Sheet 3 of 6)


ENG OIL
PSI X 10
18
14
10
6
3
2
0
1
2

ENGINE LUBRICATION OIL PRESSURE (PSI x 10)

RED	■	120	MAXIMUM
YELLOW	□	100-120	5 MINUTE LIMIT
GREEN	■	28-100	NORMAL OPERATION
YELLOW	□	22-28	IDLE OPERATION
RED	■	22	MINIMUM
BLUE	■		INSTRUMENT POWER ON
RED	●		BEGINNING OF A RED RANGE (FROM A NORMAL OPERATING REFERENCE)
YELLOW	▷	28 AND 100	BEGINNING OF A YELLOW RANGE (FROM A NORMAL OPERATING RANGE)

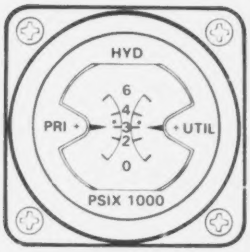

FUEL
LB X 10
145
115
105
100
80
60
40
20
0
FWD
AFT
TOTAL

FUEL QUANTITY (LB x 10)

GREEN	■	(UPPER) ABOVE 200	NORMAL OPERATION
YELLOW	□	100-200	CAUTIONARY OPERATION
RED	■	0-100	LOW LEVEL AREA
BLUE	■		INSTRUMENT POWER ON
RED	●		BEGINNING OF A RED RANGE (FROM A NORMAL OPERATING REFERENCE)
YELLOW	▷		BEGINNING OF A YELLOW RANGE (FROM A NORMAL OPERATING RANGE)

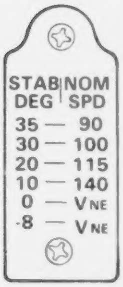
MM01-131-4C

Figure 5-1. Instrument Markings (Sheet 4 of 6)



DUAL HYDRAULIC PRESSURE
INDICATOR

3250 PSI MAXIMUM OPERATING PRESSURE
3000 PSI NORMAL OPERATING PRESSURE



STAB DEG	NOM SPD
35	90
30	100
20	115
10	140
0	V_{NE}
-8	V_{NE}

(STABILATOR POSITION INDICATOR)
PLACARD

MM04-0131-6D

Figure 5-1. Instrument Markings (Sheet 5 of 6)

Figure 5-1. Instrument Markings (Sheet 6 of 6) (Deleted)

Section III. POWER LIMITS

5-10. ENGINE POWER LIMITATIONS.

The limitations shown in figure 5-1 present absolute limitations, regardless of atmospheric conditions. For variation in power available with temperature and pressure altitude, refer to the charts in Chapter 7.

5-11. Engine Temperature Limitations.

Refer to figure 5-1 for limitations.

5-12. Engine Starter Limitations.

The pneumatic starter is capable of making the number of consecutive start cycles listed below, when exposed to the environmental conditions specified, with an interval of at least 60 seconds between the completion of one cycle and the beginning of the next cycle. A starting cycle is the interval from start initiation and acceleration of the output drive shaft, from zero rpm, to starter dropout. The 60-second delay between start attempts applies when the first attempt is aborted for any reason and it applies regardless of the duration of the first attempt. If motoring is required for an emergency, the 60-second delay does not apply.

a. At ambient temperatures of 16°C (61°F) and below, two consecutive start cycles may be made, followed by a 3-minute rest period, followed by two additional consecutive start cycles. A 30-minute rest period is then required before any additional starts.

b. At temperatures above 16°C (62°F), two consecutive start cycles may be made. A 30-minute rest period is then required before any additional start cycles.

c. Dual engine starts are prohibited.

5-13. Pneumatic Source Inlet Limits.

The minimum ground air source (pneumatic) required to start the helicopter engines is 40 psig and 30 ppm. The maximum ground-air source to be applied to the helicopter is 50 psig.

5-14. Engine Start Limits.

Refer to figure 5-1 for limitations.

5-15. Engine Overspeed Check Limitations.

Engine overspeed check in flight is prohibited.

CAUTION

Avoid prolonged operation at 94% - 96% N_R with the APU running. The APU clutch will oscillate from engaged to disengaged. This creates high loads on the clutch and shall be avoided.

5-16. Auxiliary Power Unit (APU) Operating Limits.

a. APU operation is prohibited during normal flight. After a fault or aborted start, wait 30 seconds after compressor has stopped before attempting another start. After two consecutive start attempts, wait 10 minutes before third start attempt. No more than three start attempts are permitted in one hour.

b. During prolonged ground operations greater than 30 minutes the on-comand test 19 TRAN shall be periodically executed and the XMSN 1 and XMSN 2 temperatures observed. If the temperatures exceed 130°C (266°F) the APU shall be secured and the transmission fluid allowed to cool for 30 minutes prior to resuming APU ground operations; or transmission fluid may be cooled by operating an engine with rotor turning. There is NO requirement to remove transmission side panels during extended APU ground operations. However, the transmission fluid will not get as hot under high ambient temperature conditions if the side panels are removed.

Section IV. LOADING LIMITS

5-17. CENTER OF GRAVITY LIMITS.

Center of gravity limits for the helicopter to which this manual applies and instructions for computation of the center of gravity are contained in Chapter 6.

5-18. Weight Limitations.

The maximum gross weight of the helicopter is 17,650 pounds, except for auxiliary tank configurations which are limited to 21,000 pounds.

5-18.1. TURBULENCE.

Intentional flight in extreme turbulence is prohibited.

Section V. AIRSPEED LIMITS

5-19. AIRSPEED OPERATING LIMITS.

See figure 5-2 to determine the never exceed velocity (V_{NE}) as a function of weight, altitude, and temperature. Additional airspeed limits are:

a. Maximum airspeed during autorotation or with one engine inoperative shall not exceed the greater of:

(1) 67% of V_{NE} determined from figure 5-2 using the GROSS WEIGHT line.

(2) The speed for minimum power determined from the Chapter 7 cruise charts using the MAX END/MAX R/C lines.

b. The NOM SPD values depicted on the Stabilator Position Indicator Placard (figure 5-1) shall be observed as maximum indicated airspeeds during manual stabilator operations.

c. Maximum rearward/sideward flight speed is 45 KTAS for all gross weights.

d. Maximum airspeed for stores jettison is 120 KIAS.

5-20. Airspeed Operating Limits Chart.

Referring to figure 5-2 note that a free air temperature scale and pressure altitude scale are provided in the upper grid, and a weight scale and indicated airspeed scale on the lower grid. Using the observed free air temperature and altitude obtained from the aircraft instruments and the calculated aircraft weight, enter the chart as directed in the chart example. Determine maximum airspeed at the left side of the lower grid.

AIRSPEED OPERATING LIMITS

100% ROTOR RPM

EXAMPLE

WANTED

MAXIMUM INDICATED AIRSPEED AND DENSITY ALTITUDE

KNOWN

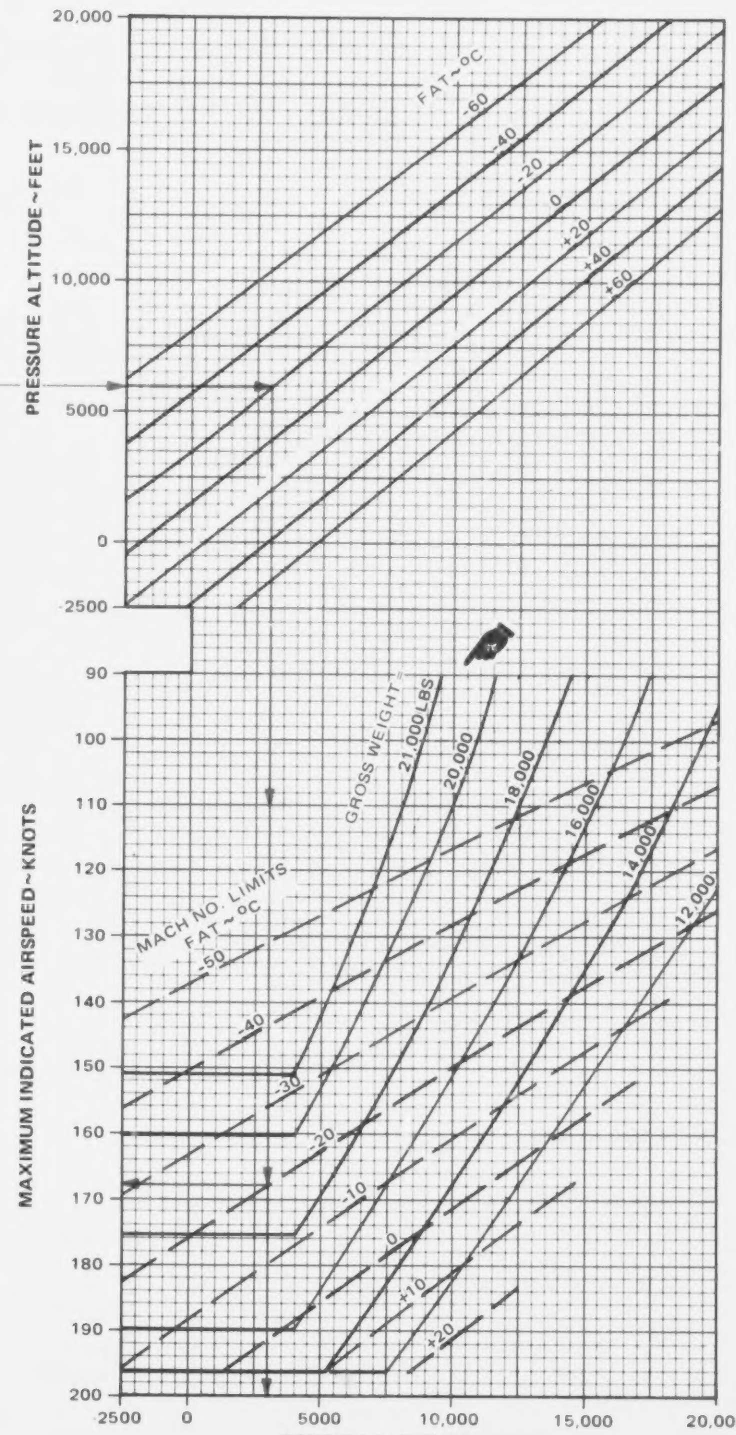
PRESSURE ALTITUDE = 6000 FEET

FAT = -20°C

GROSS WEIGHT = 18,000 POUNDS

METHOD

ENTER AT 6000 FEET PRESSURE ALTITUDE MOVE RIGHT TO FAT = -20°C. MOVE DOWN TO 18,000 POUND GROSS WEIGHT OR MACH LIMIT FAT, WHICHEVER IS ENCOUNTERED FIRST. IN THIS CASE, THE MACH LIMIT IS ENCOUNTERED FIRST. MOVE LEFT AT -20°C LINE AND READ INDICATED AIRSPEED = 168 KNOTS MOVE DOWN, READ DENSITY ALTITUDE = 3100 FEET



G

MM01-178B

Figure 5-2. Airspeed Operating Limits Chart

Section VI. MANEUVERING LIMITS

5-21. MANEUVERING LIMITS.

The AH-64A helicopter is subject to the following maneuvering restrictions. See figure 5-3 for maneuvering limits at 14,660 pounds and 17,650 pounds.

a. Avoid large pedal step inputs in arresting right hovering/low speed yawing turns greater than 60°/sec. This is to prevent excessive tail rotor drive system loads.

b. Intentional maneuvers beyond attitudes of ±30 degrees in pitch or ±60 degrees in roll are prohibited.

c. Flight hovering flight, and air taxiing with the canopy enclosure open are prohibited, except for smoke/fume elimination.

5-22. Landing Limits.

Do not complete a landing on terrain which produces a pitch attitude change from a hover greater than 7° nose up or 12° nose down; or a roll attitude greater than 10°.

Section VII. ENVIRONMENTAL RESTRICTIONS

5-23. ENVIRONMENTAL RESTRICTIONS.

a. The AH-64A helicopter is equipped with deicing and anti-icing equipment for flights into moderate icing conditions.

b. This aircraft is qualified for operation in instrument meteorological conditions.

c. An entry in DA form 2408-13 is required if helicopter was:

(1) flown in loose grass environment.
(2) operated within 10 miles of salt water.
(3) exposed to radioactivity.
(4) operated within 200 miles of volcanic area.

Section VIII. OTHER LIMITS

5-24. WING STORES CONFIGURATION.

For authorized wing stores configurations refer to figure 7-60.

5-25. ALTERATION OF CBHK VALUES.

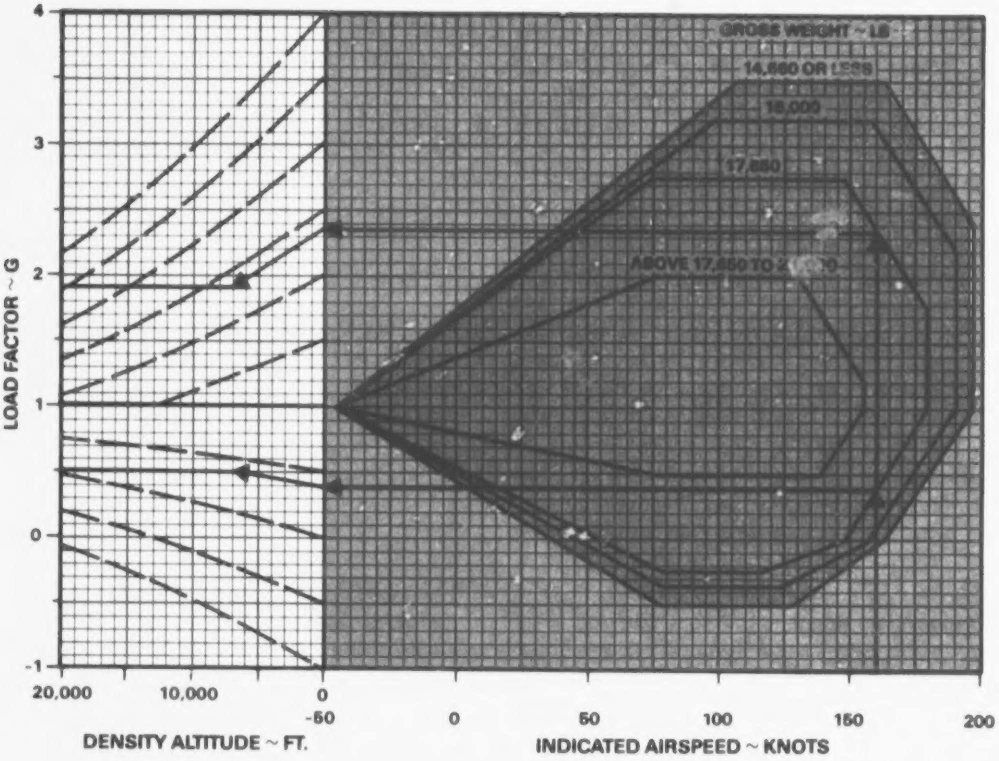
Only maintenance qualified personnel are authorized to alter values from the current CBHK values. Aviators may only verify and correct CBHK values to the current CBHK values as recorded in the aircraft logbook

5-26. TRIM AND FORCE FEEL.

Use of the Trim and Force Feed Release Switch in the "FORCE TRIM OFF" position with the helicopter on the ground is not authorized. In Flight operation with the Trim and Force Feel Release Switch in the FORCE TRIM OFF position is authorized when briefed and the FORCE TRIM OFF selection is acknowledged by both crew members.

🟩 NORMAL OPERATING RANGE

🟥 PROHIBITED OPERATION



EXAMPLE

WANTED

MAXIMUM AND MINIMUM LOAD FACTOR

KNOWN

GROSS WEIGHT = 17,650 POUNDS
DENSITY ALTITUDE = 7000 FEET
AIRSPEED = 160 KIAS

METHOD

ENTER AT V = 160 KT. MOVE UP TO UPPER AND LOWER ENVELOPE BOUNDARIES FOR GROSS WEIGHT = 17,650 POUNDS.
MOVE LEFT TO DENSITY ALTITUDE OF ZERO FEET.
SLIDE TO LEFT ALONG DASHED LINES TO 7000 FEET DENSITY ALTITUDE.
MOVE LEFT TO LOAD FACTOR SCALE, READ MAX G = 1.9, MIN G = 0.5.

🟩 🟥
G R
MM01-207

Figure 5-3. Flight Envelope Chart

CHAPTER 6

WEIGHT/BALANCE AND LOADING

SECTION I. GENERAL

6-1. INTRODUCTION.

This chapter provides information required for helicopter loading and computing of weight and balance.

6-2. Extent of Coverage.

This chapter contains sufficient instructions and data so that an aviator, knowing the basic weight and moment of the helicopter, can compute any combination of weight and balance using the prescribed Army charts and forms.

6-3. Helicopter Class.

Army AH-64A helicopter is in Class 1. Additional directives governing weight and balance of Class 1 aircraft forms and records are contained in AR 95-1, AR 95-3, DA PAM 738-751 and TM 55-1500-342-23.

6-4. Helicopter Compartments and Stations.

The helicopter has many compartments; most of them contain electronic or other equipment. Figure 6-1 shows the general location of the major compartments and equipment. The boundaries of all compartments and a listing of the equipment in each compartment are provided in the helicopter records Chart A - Basic Weight Checklist, DD Form 365-1. The compartments of primary concern to the pilot, when loading, are the CPG and pilot crew stations, left aft storage bay, and survival kit bay. These compartments may contain personal items or extra equipment not accounted for in basic weight. (Refer to paragraph 6-28.) Any additional items must be entered on the Weight and Balance Form F (DD 365-4).

a. **CPG Crew Station**. The CPG station extends from station 35.5 to station 115.0. The CPG nominal centroid is at station 82.2, but the seat can be adjusted so the CPG centroid can vary from station 81.9 to 82.8. This produces a small moment variation and should be ignored.

b. **Pilot Crew Station.** The pilot station extends from station 115.0 to station 168.0. The pilot nominal centroid is at station 143.3, but the seat can be adjusted so the pilot centroid can vary from station 142.8 to 143.8. This produces a small moment change and should be ignored.

c. **Left Aft Storage Bay**. The aft storage bay is on the left side from fuselage station 280.0 to 310.0 and can be loaded to 15 pounds per square foot with a capacity of 120 pounds. The floor area is approximately 7.9 square feet and the volume is approximately 21 cubic feet. Floor tiedown fittings are in place to accommodate the flyaway kit.

d. **Survival Kit Bay**. The survival kit bay is reached from either side. From fuselage station 310.0 to 340.0, it can be loaded to 15 pounds per square foot with a capacity of 100 pounds. The floor area is approximately 7.3 square feet and the volume is approximately 17 cubic feet. Floor tiedown fittings are in place to accommodate the survival kit.

NOTE

When loading these two bays, check for exceeding the aft cg limits.

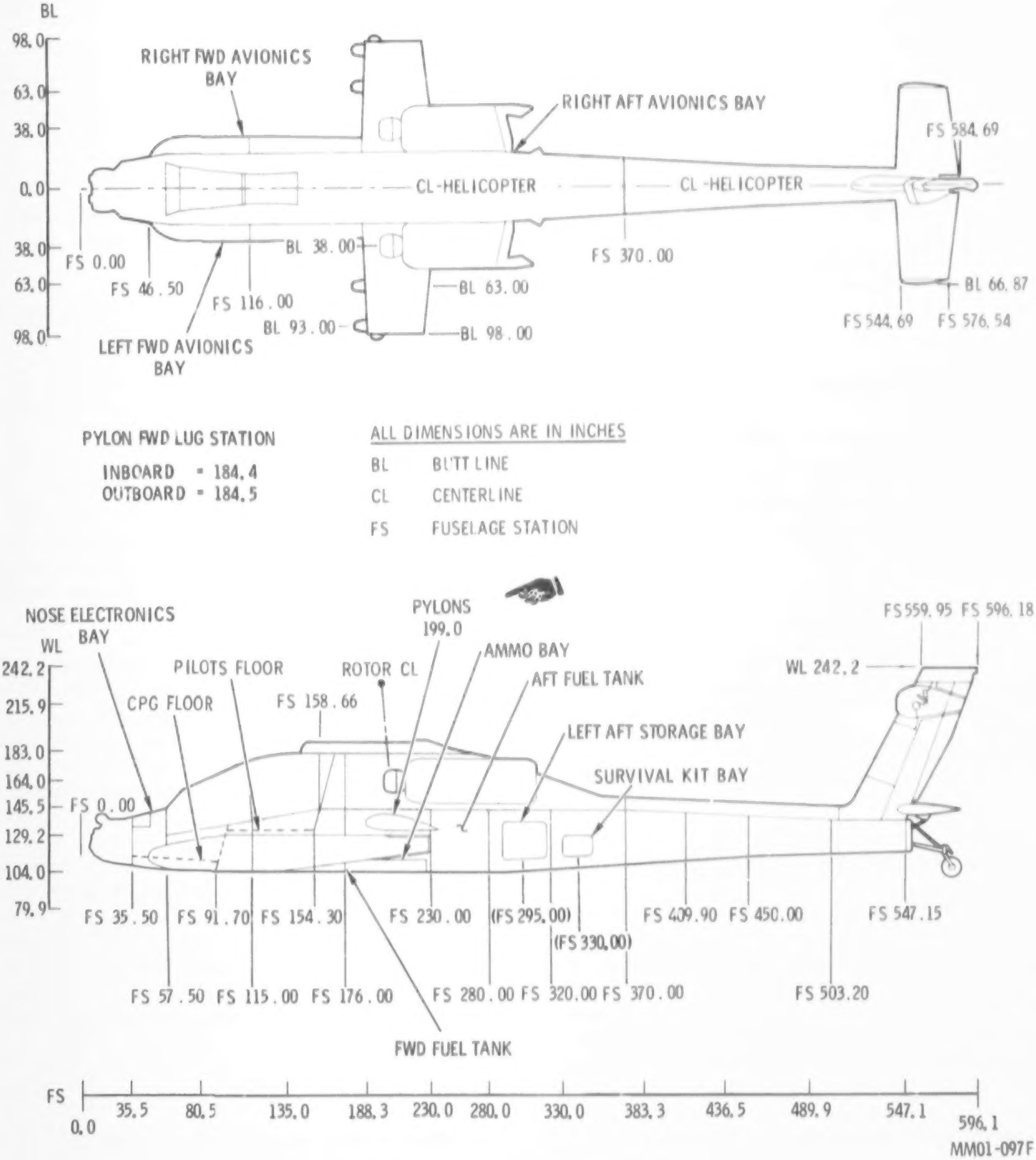

BL
98.0
63.0
38.0
0.0
38.0
63.0
98.0
RIGHT FWD AVIONICS BAY
RIGHT AFT AVIONICS BAY
FS 584.69
CL-HELICOPTER
CL-HELICOPTER
FS 0.00
FS 46.50
FS 116.00
BL 38.00
BL 63.00
BL 93.00
BL 98.00
FS 370.00
BL 66.87
FS 544.69
FS 576.54
LEFT FWD AVIONICS BAY
PYLON FWD LUG STATION
INBOARD = 184.4
OUTBOARD = 184.5
ALL DIMENSIONS ARE IN INCHES
BL BUTT LINE
CL CENTERLINE
FS FUSELAGE STATION
NOSE ELECTRONICS BAY
WL
242.2
215.9
183.0
164.0
145.5
129.2
104.0
79.9
PYLONS 199.0
AMMO BAY
AFT FUEL TANK
PILOTS FLOOR
ROTOR CL
CPG FLOOR
FS 158.66
LEFT AFT STORAGE BAY
SURVIVAL KIT BAY
FS 559.95
FS 596.18
WL 242.2
FS 0.00
FS 35.50
FS 91.70
FS 154.30
FS 230.00
(FS 295.00)
(FS 330.00)
FS 409.90
FS 450.00
FS 547.15
FS 57.50
FS 115.00
FS 176.00
FS 280.00
FS 320.00
FS 370.00
FS 503.20
FWD FUEL TANK
FS
0.0
35.5
80.5
135.0
188.3
230.0
280.0
330.0
383.3
436.5
489.9
547.1
596.1
MM01-097F

Figure 6-1. Station Diagram

SECTION II. WEIGHT AND BALANCE

6-5. WEIGHT AND BALANCE.

This section contains information needed to compute the weight and balance for an individual helicopter by using the prescribed standard charts and forms.

6-6. Weight Definitions.

a. **Basic Weight**. The normal basic weight of this helicopter includes wing pylons, all fixed operating equipment, 30mm gun, all oil, and trapped fuel. It is only necessary to add the variables or expendables to these items for the missions.

NOTE

The basic weight of the helicopter will vary with mission requirements and structural modifications such as addition or removal of wing pylons, peculiar kits, 30mm gun, turret, ammo handling system, etc. A continuing record of an individual helicopter's basic weight is maintained on Chart C – Basic Weight and Balance Record, DD Form 365-3.

b. **Operating Weight**. The operating weight of the helicopter is the basic weight plus those variables which remain substantially constant for a particular mission. These items include crew, baggage, rocket launchers, Hellfire launchers, and any emergency or extra equipment that may be required.

c. **Gross Weight**. The gross weight is the total weight of the helicopter and its contents.

6-7. Balance Definitions.

a. **Reference Datum**. The reference datum is an imaginary vertical plane from which all horizontal distances are measured (in inches) for balance purposes.

b. **Arm**. For balance purposes, the term ARM is the horizontal distance (in inches) from the reference datum to the center of gravity of a given item. For special cases, ARM can be determined from figure 6-1. For the AH-64A helicopter, ARM and fuselage station (FS) are the same.

c. **Moment**. Moment is the weight of an item multiplied by its arm. For the AH-64A helicopter, moment divided by 100 (moment/100) is used to simplify calculations by reducing the number of digits.

NOTE

Throughout this chapter, moment/100 figures have been rounded off to the nearest whole number. When moments from other sources are being used, they must be divided by 100 and rounded off.

d. **Average Arm**. Average arm is the arm obtained by adding the weights and the moments of a number of items and dividing the total moment by the total weight.

e. **Basic Moment**. Basic moment is the sum of the moments of all items making up the basic weight with respect to the helicopter reference datum.

f. **Center of Gravity (CG)**. Center of gravity is the point about which the helicopter would balance if suspended. Distance from the reference datum is found by dividing the total moment by the gross weight of the helicopter.

g. **CG Limits**. The cg limits are the extremes of movement to which the helicopter cg can travel without endangering controllability or structural integrity. The cg of the loaded helicopter must remain within these limits at takeoff, throughout flight, and during landing.

6-8. Chart C – Basic Weight and Balance Record, DD Form 365-3.

Chart C is a continuous history of the basic weight and moment resulting from structural and equipment changes in service. At all times, the last weight and moment/100 entries are considered the current weight and balance status of the basic helicopter.

6-9. Loading Data.

The loading data in this chapter is intended to provide information necessary to work loading problems for the helicopter. From this data, weight and moment/100 are obtained for all variable load items and are added to the current basic weight and moment/100 from Chart C (DD Form 365-3) to determine the gross weight and moment/100 using Form F (DD Form 365-4). The effect on helicopter cg of expending the fuel and armament in a logical sequence may be checked by subtracting the weight and moment/100 of each item from the takeoff gross weight and moment/100; then, checking the new moment (or helicopter cg) with the cg limits chart. This check should be made to determine if the cg will remain within limits during the entire flight. Refer to paragraph 6-13 for helicopter cg management.

6-10. Weight and Balance Clearance Form F, DD Form 365-4.

Form F is the summary of the actual disposition of load in the helicopter. It records the balance status of the helicopter step-by-step. It serves as a work sheet on which to record weight and balance calculations and any corrections that must be made to ensure that the helicopter will be within weight and cg limits throughout the mission. There are two versions of this form: Transport and Tactical. Each was designed to provide for the respective loading arrangement of these two types of aircraft. The general use and fulfillment of either version is the same.

6-11. Deleted.

6-12. Deleted.

6-13. Center of Gravity Management.

This paragraph contains fuel management methods that can be used to maintain cg limits in flight and during the expending of external stores for some helicopter configurations. Table 6-1 lists cg shift as stores are expended. When the storage bays are used for miscellaneous equipment it is possible to cause an aft cg condition.

a. **Fuel Loading.** The helicopter takeoff cg can be moved by loading either tank with more fuel than the other. Example: to move the cg forward, fill the forward tank (1014 pounds of JP-4) and reduce fuel load in the aft tank depending on cg shift required. For some missions, it may be necessary to reduce the stowed weight.

b. **Table of Expendables.** The table of expendables (table 6-1) provides a guide for quick definition of intermediate flight cg as stores/fuel are expended at various gross weights and at forward and aft cg limits. Table 6-1 eliminates calculation of intermediate cg when the helicopter is well within limits. When flight limits are doubtful or when operation is close to cg limits, a detailed calculation must be made to determine any cg limit violation.

c. **Fuel Management**. The following example presents normal cg/fuel management where each fuel tank supplies an engine. This procedure prevents drastic helicopter cg shifts as fuel is expended. Refer to Chapter 2 for fuel system details.

EXAMPLE:

(1) Using table 6-1, refer to FUEL EXPENDED 500 lb EACH line. Note that fuel expended at 15,000 gross weight at forward cg limit produces a helicopter forward cg shift of −0.13 inch; and at aft cg limit, +0.29 inch. When the helicopter cg is at the combined fuel cg (202.8 inches) expending fuel will produce a zero shift. This is true only when the forward tank fuel remains in the lower portion of the L-shape tank. Refer to paragraph 6-16.

(2) When filling the forward tank into the upper portion of the L-shape, the combined fuel expended cg moves aft to 212.4 inches which means that the helicopter cg will always shift forward during fuel burn-off in this area.

Refer to the 1000 lb fuel expended each tank line in table 6-1. Note that fuel expended at 15,000 gross weight at aft cg limit is +0.41 inches. This is correct when the total 2,000 pounds of fuel is expended, but this includes a helicopter cg shift forward during initial fuel burn-off due to the forward L-shaped tank.

(3) For the full fuel example based on a conservative gross weight of 15,000 pounds and cg of 201.0 inches, 208 pounds of aft fuel must be transferred so that all fuel can be expended equally. A helicopter cg shift of -1.49 to -1.68 inches is produced depending on when the transfer occurs. When working with full fuel, it is advisable to calculate several intermediate points and determine when it's best to transfer fuel.

Table 6-1. Helicopter CG Movement When Load Items are Expended

		When Aircraft CG Near Fwd CG Limit			When Aircraft CG Near Aft CG Limit		
Aircraft Gross Weight		13000	15000	17650	13000	15000	17650
Expended Items	Qty						
Ammo	200	+ 0.32	+ 0.27	+ 0.23	+ 0.39	+ 0.34	+ 0.27
Ammo	600	+ 0.19	+ 0.16	+ 0.14	+ 0.41	+ 0.35	+ 0.25
Ammo	1200	- 0.08	- 0.08	- 0.06	+ 0.37	+ 0.31	+ 0.18
H-F Missiles	8	+ 0.66	+ 0.57	+ 0.48	+ 1.05	+ 0.89	+ 0.68
H-F Missiles	16	+ 1.41	+ 1.21	+ 1.01	+ 2.25	+ 1.88	+ 1.44
Rockets 27.1 lb	38	+ 1.00	+ 0.86	+ 0.72	+ 1.51	+ 1.28	+ 0.99
Rockets ea.	76	+ 2.18	+ 1.85	+ 1.53	+ 3.21	+ 2.75	+ 2.11
Chaff	30	- 0.23	- 0.20	- 0.17	- 0.22	- 0.19	- 0.16
*Fuel 500 lb per tank		- 0.15	- 0.13	- 0.11	+ 0.35	+ 0.29	+ 0.15
Fuel 1000 lb per tank			- 0.48	- 0.40		+ 0.41	+ 0.16
Fuel Full tank			- 2.31	- 1.91		- 1.18	- 1.21

Note: A plus (+) means aircraft CG moves aft and negative (–) means forward CG movement.

*The above fuel values represent the total fuel on board such that the 500 lb (1000 lb or full) in each tank is the starting point and the expended fuel is 500 lb (1000 lb or full), leaving zero fuel in each tank.

best copy available

SECTION III. FUEL AND OIL

6-14. OIL MOMENTS.

Oil is shown in basic weight, Chart F (DD 365-4). Entries are not required.

6-15. FUEL WEIGHT AND MOMENT.

When the actual or planned fuel loading (pounds or gallons) and type is known, the total fuel weight and moment/100 can be determined from the fuel moment Table 6-2. The table presents JP-4, JP-5 and JP-8 fuel quantity.

6-16. Fuel Moments.

The forward fuel moment calculations are complicated by the L-shape of the tank. Consider the tank being filled from empty to 132.8 gallons; the fuel cg remains constant at 150.6 inches. From 132.8 gallons to full (156 gallons), the cg of the total fuel moves aft linearly to 153.4 inches at capacity. The aft fuel cg is constant at 255 inches.

6-17. Wing Auxiliary Fuel and Tanks.

The auxiliary fuel tanks are normally installed on the wing pylons in sets of two or four and are for extending the helicopter ferry range. Plumbing from the fuselage to the tank is provided with each tank. Each tank has a capacity of approximately 230 gallons. Table 6-3 lists the weight and moment/100 of each fuel tank, wing plumbing and total fuel for JP-4, JP-5, and JP-8. Note that the data are given for one tank, wing plumbing, and indicated fuel so that any combination can be determined. The table can be used for inboard and outboard locations because the small moment/100 differences can be ignored. Remember to add the tank, and specific fuel together for one location, then multiply by 2 or 4 depending on the number of tanks carried. Add wing plumbing for 2 or 4 tanks as appropriate.

All data on pages 6-7 thru 6-10 deleted.

16. Ref 16 - Divide moment/100 by weight (listed in ref 15) and multiply by 100 to determine estimated landing cg (inches) in fuselage station.

17. Using the CG LIMITS CHART (Figure 6-6), locate the helicopter's takeoff and landing weight and center of gravity. Locate the helicopter takeoff and landing weights cg's (ref 12 and ref 15) on the cg limits chart. Determine the take-off limits from the cg limits chart and list them on form F in the limitations block, do likewise for the estimated landing condition. When these points are well within the normal cg limits, it is then safe to assume the aircraft cg will remain within limits throughout the flight. When the points are close to the forward or aft limits, then further analysis must be made. Refer to paragraph 6-13 for helicopter cg management.

18. Signatures: The necessary signatures must appear at the bottom of the form.

6-12. Sample Problem - Loading to a Primary Mission Weight and cg.

Calculate the weight and balance of the helicopter for a typical primary mission. The loading and calculations are listed below. An example Form F is shown in figure 6-3:

a. Given present basic weight from Chart C:

Basic Weight is 11,387 pounds
Basic moment is 23,723 in.-lb/100

b. Known useful load items to be added (refer to load tables):

	Weight (lb)	Moment (in.-lb/100)
Copilot / Gunner	170	140
Pilot	230	330
30mm Ammo (325 rds)	250	466
Hellfire Launchers (2)	278	528
Hellfire Missiles (8)	788	1502
Full Chaff Dispenser	17	85
FWD Fuel (130.8 gal., JP-4)	850	1280
AFT Fuel (130.8 gal., JP-4)	850	2168
Useful Load Total	3,433	6,499

c. Combine basic weight from chart C with useful load items to obtain take-off conditon:

Takeoff weight is 14,818 pounds
Takeoff moment is 30,222 in.-lb/100
Takeoff cg is 203.95 inches

NOTE

To determine cg, divide the moment by the weight and multiply by 100.

$$\frac{30,222}{14,818}\ (100) = 203.95$$

d. Determine the estimated landing condition by subtracting the expended missiles, ammunition, and fuel. The missiles and ammunition expended can be obtained from tables 6-5 and 6-8. Or if completely expended, the entries on Form F can be used as shown in figure 6-3. The expended fuel is more complicated to calculate because the forward tank is L-shaped and the lower portion of the aft tank is not symmetrical. It is advisable to show the expended fuel calculations on Form F (figure 6-3). Fuel can be transferred from one tank to the other during flight but this example does not require any transfer. Refer to paragraph 6-13 for options on fuel management to maintain helicopter cg. Fuel weight and moment is determined by first estimating the amount of fuel remaining at end of flight. The example uses an estimated 200 pounds remaining in the aft tank. So the aft fuel calculations are:

	Weight (lb)	Moment (in.-lb/100)
Starting Quantity	850	2168
Fuel Remaining (est)	-200	-510
Fuel Expended Aft Tank	650	1658

Normal fuel management is with each tank supplying an engine. Thus, assuming equal fuel consumption, the forward tank will also have 200 pounds of fuel remaining.

	Weight (lb)	Moment (in.-lb/100)
Starting Quantity	850	1280
Fuel Remaining (est)	-200	-301
Fuel Expended Forward Tank	650	979

e. Now all the expendables can be listed on Form F; they are:

	Weight (lb)	Moment (in.-lb/100)
Chaff Cartridges	10	49
Hellfire Missiles (8)	788	1502
30mm Ammo (325 rds)	250	466
FWD Fuel (100.0 gal.)	650	979
AFT Fuel (100.0 gal.)	650	1658
Total Expendables	2,348	4,654

f. The estimated landing condition is determined by subtracting expendables from the corrected takeoff condition:

Landing weight is 12,470 pounds
Landing moment is 25,568 in.-lb/100
Landing cg is 205.02 inches

g. Determine if the helicopter corrected takeoff cg and the estimated landing cg, as calculated on Form F, are within cg limits by using the cg limits graph shown in figure 6-6. Locating these points on the cg limits graph shows that they are well within limits. In this example, it is not necessary to check intermediate expendable cg's, as all will fall within the cg limits as explained in paragraph 6-13.

6-13. Center of Gravity Management.

This paragraph contains fuel management methods that can be used to maintain cg limits in flight and during the expending of external stores for some helicopter configurations. Table 6-1 lists cg shift as stores are expended. When the storage bays are used for miscellaneous equipment it is possible to cause an aft cg condition.

a. **Fuel Loading.** The helicopter takeoff cg can be moved by loading either tank with more fuel than the other. Example: to move the cg forward, fill the forward tank (1014 pounds of JP-4) and reduce fuel load in the aft tank depending on cg shift required. For some missions, it may be necessary to reduce the stowed weight.

b. **Table of Expendables.** The table of expendables (table 6-1) provides a guide for quick definition of intermediate flight cg as stores/fuel are expended at various gross weights and at forward and aft cg limits. Table 6-1 eliminates calculation of intermediate cg when the helicopter is well within limits. When flight limits are doubtful or when operation is close to cg limits, a detailed calculation must be made to determine any cg limit violation.

c. **Fuel Management.** The following example presents normal cg/fuel management where each fuel tank supplies an engine. This procedure prevents drastic helicopter cg shifts as fuel is expended. Refer to Chapter 2 for fuel system details.

EXAMPLE:

(1) Using table 6-1, refer to FUEL EXPENDED 500 lb EACH line. Note that fuel expended at 15,000 gross weight at forward cg limit produces a helicopter forward cg shift of −0.13 inch; and at aft cg limit, +0.29 inch. When the helicopter cg is at the combined fuel cg (202.8 inches) expending fuel will produce a zero shift. This is true only when the forward tank fuel remains in the lower portion of the L-shape tank. Refer to paragraph 6-16.

(2) When filling the forward tank into the upper portion of the L-shape, the combined fuel expended cg moves aft to 212.4 inches which means that the helicopter cg will always shift forward during fuel burn-off in this area.

Refer to the 1000 lb fuel expended each tank line in table 6-1. Note that fuel expended at 15,000 gross weight at aft cg limit is +0.41 inches. This is correct when the total 2,000 pounds of fuel is expended, but this includes a helicopter cg shift forward during initial fuel burn-off due to the forward L-shaped tank.

(3) For the full fuel example based on a conservative gross weight of 15,000 pounds and cg of 201.0 inches, 208 pounds of aft fuel must be transferred so that all fuel can be expended equally. A helicopter cg shift of -1.49 to -1.68 inches is produced depending on when the transfer occurs. When working with full fuel, it is advisable to calculate several intermediate points and determine when it's best to transfer fuel.

Table 6-1. Helicopter CG Movement When Load Items are Expended

		When Aircraft CG Near Fwd CG Limit			When Aircraft CG Near Aft CG Limit		
Aircraft Gross Weight		**13000**	**15000**	**17650**	**13000**	**15000**	**17650**
Expended Items	Qty						
Ammo	200	+ 0.32	+ 0.27	+ 0.23	+ 0.39	+ 0.34	+ 0.27
Ammo	600	+ 0.19	+ 0.16	+ 0.14	+ 0.41	+ 0.35	+ 0.25
Ammo	1200	- 0.08	- 0.08	- 0.06	+ 0.37	+ 0.31	+ 0.18
H-F Missiles	8	+ 0.66	+ 0.57	+ 0.48	+ 1.05	+ 0.89	+ 0.68
H-F Missiles	16	+ 1.41	+ 1.21	+ 1.01	+ 2.25	+ 1.88	+ 1.44
Rockets 27.1 lb	38	+ 1.00	+ 0.86	+ 0.72	+ 1.51	+ 1.28	+ 0.99
Rockets ea.	76	+ 2.18	+ 1.85	+ 1.53	+ 3.21	+ 2.75	+ 2.11
Chaff	30	- 0.23	- 0.20	- 0.17	- 0.22	- 0.19	- 0.16
*Fuel 500 lb per tank		- 0.15	- 0.13	- 0.11	+ 0.35	+ 0.29	+ 0.15
Fuel 1000 lb per tank			- 0.48	- 0.40		+ 0.41	+ 0.16
Fuel Full tank			- 2.31	- 1.91		- 1.18	- 1.21

Note: A plus (+) means aircraft CG moves aft and negative (-) means forward CG movement.

*The above fuel values represent the total fuel on board such that the 500 lb (1000 lb or full) in each tank is the starting point and the expended fuel is 500 lb (1000 lb or full), leaving zero fuel in each tank.

SECTION III. FUEL AND OIL

6-14. OIL MOMENTS.

Oil is shown in basic weight, Chart F (DD 365F). Entries are not required.

6-15. FUEL WEIGHT AND MOMENT.

When the actual or planned fuel loading (pounds or gallons) and type is known, the total fuel weight and moment/100 can be determined from the fuel moment Table 6-2. The table presents JP-4, JP-5 and JP-8 fuel quantity.

6-16. Fuel Moments.

The forward fuel moment calculations are complicated by the L-shape of the tank. Consider the tank being filled from empty to 132.8 gallons; the fuel cg remains constant at 150.6 inches. From 132.8 gallons to full (156 gallons), the cg of the total fuel moves aft linearly to 153.4 inches at capacity. The aft fuel cg is constant from 50 pounds to capacity.

6-17. Wing Auxiliary Fuel and Tanks.

The auxiliary fuel tanks are normally installed on the wing pylons in sets of two or four and are for extending the helicopter ferry range. Plumbing from the fuselage to the tank is provided with each tank. Each tank has a capacity of approximately 230 gallons. Table 6-3 lists the weight and moment/100 of each fuel tank, wing plumbing and total fuel for JP-4, JP-5, and JP-8. Note that the data are given for one tank, wing plumbing, and indicated fuel so that any combination can be determined. The table can be used for inboard and outboard locations because the small moment/100 differences can be ignored. Remember to add the tank, wing plumbing and specific fuel together for one location, then multiply by 2 or 4 depending on the number of tanks carried. For pylons, refer to paragraph 6-21.

Table 6-2. Fuel

JP-4 Density = 6.5 lb/gal
JP-5 Density = 6.8 lb/gal
JP-8 Density = 6.7 lb/gal

Forward Tank

Weight (lb)	Moment 100	U.S. Gallons JP-4	U.S. Gallons JP-5 or JP-8
50	75	7.7	7.4
100	151	15.4	14.8
150	226	23.1	22.2
200	301	30.8	29.6
250	377	38.5	37.0
300	452	46.2	44.4
350	527	53.8	51.9
400	602	61.5	59.3
450	678	69.2	66.7
500	753	76.9	74.1
550	828	84.6	81.5
600	904	92.3	88.9
650	979	100.0	96.3
700	1054	107.7	103.7
750	1130	115.4	111.1
800	1205	123.1	118.5
850	1280	130.8	125.9
900	1359	138.5	133.3
950	1444	146.2	140.7
1000	1529	153,9	148.2
1014	1556	156.0	–
1053	1615	–	156.0

Aft Tank

Weight (lb)	Moment 100	U.S. Gallons JP-4	U.S. Gallons JP-5 or JP-8
50	127	7.7	7.4
100	255	15.4	14.8
150	382	23.1	22.2
200	510	30.8	29.6
250	638	38.5	37.0
300	765	46.2	44.4
350	893	53.8	51.9
400	1020	61.5	59.3
450	1148	69.2	66.7
500	1275	76.9	74.1
550	1403	84.6	81.5
600	1530	92.3	88.9
650	1658	100.0	96.3
700	1785	107.7	103.7
750	1913	115.4	111.1
800	2040	123.1	118.5
850	2168	130.8	125.9
900	2295	138.5	133.3
950	2423	146.2	140.7
1000	2550	153.9	148.2
1050	2678	161.5	155.6
1100	2805	169.2	163.0
1150	2933	176.9	170.4
1200	3060	184.6	177.8
1250	3188	192.3	185.2
1300	3315	200.0	192.6
1350	3443	207.7	200.0
1400	3570	215.4	207.4
1430	3646	220.0	–
1485	3787	–	220.0

Table 6-3. Wing Auxiliary Fuel

JP-4 Density = 6.5 lb/gal
JP-5 Density = 6.8 lb/gal
JP-8 Density = 6.7 lb/gal

Auxiliary Tank

Item	Weight Each (lb)	Moment / 100	U.S. Gallons
Auxiliary Fuel Tank	140.0	268	–
Wing Tank Plumbing			
2 Tanks	16.0	35	–
4 Tanks	20.0	43	–
JP-4 Fuel (Capacity)	1495.0	2906	230.0
JP-5 Fuel (Capacity)	1564.0	3040	230.0
JP-8 Fuel (Capacity)	1541.0	2996	230.0

Note: Weight and moment are shown for one tank with fuel; and must be doubled for two inboard or multiplied by 4 when inboard and outboard stations are used.

Add wing tank plumbing for 2 tanks or 4 tanks as appropriate.

SECTION IV. PERSONNEL

6-18. GENERAL.

Personnel provisions consist of the pilot and CPG located in the cockpit.

6-19. Personnel Moments.

Always try to use exact weight of each crew member including all equipment and any personal items stored in the crewstation. If weighing facilities are not available, then use the best estimate available. The table presents the crew cg with the seat in its nominal location.

Table 6-4. Crew Weight

Crew Member Weight Including Equipment (lb)	Copilot Station		Pilot Station	
	Nominal Arm (in.)	Moment (in.-lb/100)	Nominal Arm (in.)	Moment (in.-lb/100)
100	82.2	82	143.3	143
110	82.2	90	143.3	158
120	82.2	99	143.3	172
130	82.2	107	143.3	186
140	82.2	115	143.3	201
150	82.2	123	143.3	215
160	82.2	132	143.3	229
170	82.2	140	143.3	244
180	82.2	148	143.3	258
190	82.2	156	143.3	272
200	82.2	164	143.3	287
210	82.2	173	143.3	301
220	82.2	181	143.3	315
230	82.2	189	143.3	330
240	82.2	197	143.3	344
250	82.2	206	143.3	358

SECTION V. MISSION EQUIPMENT

6-20. MISSION EQUIPMENT.

The AH-64A helicopter mission equipment includes pylons, Hellfire missiles and launchers, 2.75 rockets and launchers, 30mm ammunition, and chaff cartridges. External fuel tanks are described in paragraph 6-17. All electronic mission equipment is part of basic weight and may be found in Chart A (Form DD 365-1).

6-21. Pylons.

The wing pylons should be included on CHART A as part of the Basic Weight. Check CHARTS A & C to be sure this has been done. If pylons are installed, and they are not listed on CHART A, they should be listed on CHART C and CHART A, and included in the Basic Weight from this date on.

6-22. Hellfire Launchers.

Figure 6-4 presents the M-272 Hellfire launchers, in pairs, weight, and moment/100. When four launchers are required, double the numbers.

6-23. Hellfire Missiles.

The present training, dummy, and laser seeker missiles weigh the same. Table 6-5 lists the weight and moment/100 of each missile accumulated to a capacity of four missiles per launcher. When a pair of inboard launchers are filled to capacity, double the (missile no. 4) weight and moment/100. When four launchers are used, multiply the numbers by four.

6-24. Rocket Launchers.

Figure 6-4 presents the M-261 2.75-inch rocket launchers, in pairs, weight, and moment/100. Double the weight and moment/100 when four launchers are used.

6-25. Rockets (2.75-inch).

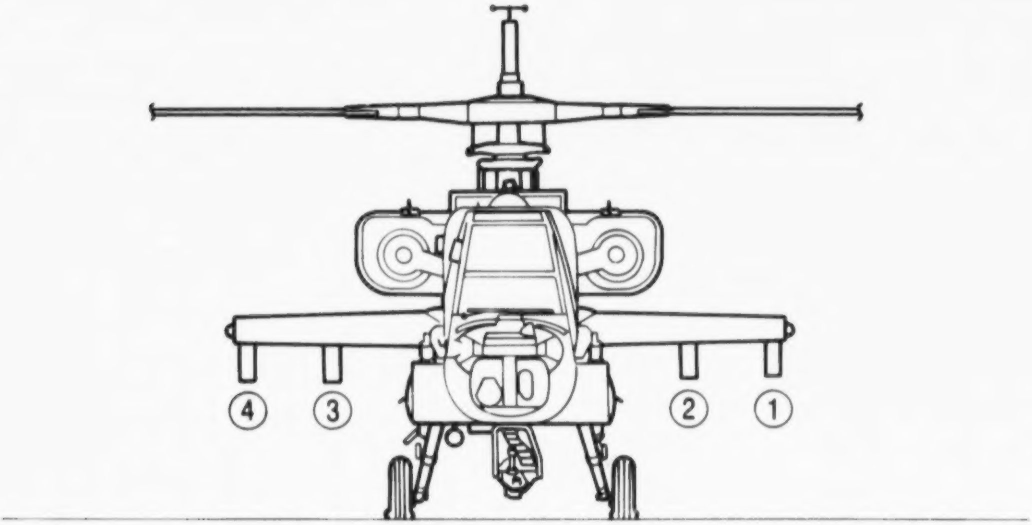
Present training rockets are designated H519 with an M156 warhead, M423 fuse, and an MK 40 MOD 3 rocket motor. Dummy and training rockets are the same weight. Table 6-6 lists the 2.75-inch rocket accumulated weight and moment/100 to a capacity of 19 per launcher. Select the correct number of rockets,then double the weight and moment/100 for a pair of launchers loaded evenly. Table 6-7 lists an MPSM warhead with a MK 66 rocket motor. The tables are presented so that any combination or mix can be easily determined for a launcher.

6-26. Ammunition (30mm).

Table 6-8 presents the M-788 or M-789 30mm linkless aluminum case ammunition accumulated weight, and moment/100 to a capacity of 1200 rounds. Approximately 104 rounds are in the right chute and the remainder is in the magazine. A note at the bottom of the table allows conversion of the table numbers to ADEN or DEFA amunition.

6-27. Chaff Cartridges.

The helicopter survivability equipment is a kit. It is added to the helicopter as dictated by mission requirements. The electronic equipment, controls, and chaff supports are part of the basic weight and are listed in Chart A (DD 365-1). Table 6-9 lists the chaff dispenser empty and the chaff dispenser (full) with 30 chaff (M-1) cartridges. These values are to be used on Form F (DD 365-4) when chaff is on board.



Pylons and Launchers

Item	Stations	Weight of Pair (lb)	Moment (in.-lb/100)
Pylons - Inboard or Outboard	2 & 3 or 1 & 4	115.0	228
M-272 Hellfire Launchers	2 & 3 or 1 & 4	282.0	535
M-261 Rocket Launchers	2 & 3 or 1 & 4	173.6	344

NOTE

- FWD Hooks are at F.S. 184.5
  (Both Inboard & Outboard Pylons)
- Pylons should not be listed on form F
  (See Para 6-21)

MM01-219C

Figure 6-4. External Stores and Stations

Table 6-5. Hellfire Missile Loading

Item	Qty	Inboard Station 2,3 or Outboard Station 1, 4	
		Accum Weight (lb)	Moment (in.-lb/100)
Missile	1	100.9	192
Missile	2	201.7	384
Missile	3	302.6	576
Missile	4	403.5	768

Table 6-6. 2.75 Inch Rocket Loading for H519 or Dummy

Item	Qty	Inboard Station 2,3 or OutboardStation 1, 4	
		Accum Weight (lb)	Moment (in.-lb/100)
H519 Rocket	1	20.6	41
Rocket	2	41.2	81
Rocket	3	61.8	122
Rocket	4	82.4	162
Rocket	5	103.0	203
Rocket	6	123.6	243
Rocket	7	144.2	284
Rocket	8	164.8	324
Rocket	9	185.4	365
Rocket	10	206.0	406
Rocket	11	226.6	446
Rocket	12	247.2	487
Rocket	13	267.8	527
Rocket	14	288.4	568
Rocket	15	309.0	608
Rocket	16	329.6	649
Rocket	17	350.2	690
Rocket	18	370.8	730
Rocket	19	391.4	771

Table 6-7. 2.75 Inch Rocket Loading for MPSM Warhead with MK66 Motor

Item	Qty	Inboard Station 2,3 or Outboard Station 1, 4	
		Accum Weight (lb)	Moment (in.-lb/100)
Rocket	1	27.1	51
Rocket	2	54.2	102
Rocket	3	81.3	154
Rocket	4	108.4	205
Rocket	5	135.5	257
Rocket	6	162.6	308
Rocket	7	189.7	359
Rocket	8	216.8	411
Rocket	9	243.9	462
Rocket	10	271.0	513
Rocket	11	298.1	565
Rocket	12	325.2	616
Rocket	13	352.3	667
Rocket	14	379.4	719
Rocket	15	406.5	770
Rocket	16	433.6	821
Rocket	17	460.7	873
Rocket	18	487.8	924
Rocket	19	514.9	975

Table 6-8. Ammunition Loading for M-788 or M-789 30mm Rounds (Aluminum Cartridges)

Number of Rounds	Weight (lb)	Moment (in.-lb/100)
50	38.5	42
100	77.0	110
150	115.5	189
200	154.0	269
250	192.5	346
300	231.0	427
350	269.5	504
400	308.0	585
450	346.5	662
500	385.0	744
550	423.5	819
600	462.0	905
650	500.5	988
700	539.0	1063
750	577.5	1146
800	616.0	1221
850	654.5	1304
900	693.0	1379
950	731.5	1462
1000	770.0	1537
1050	808.5	1620
1100	847.0	1696
1150	885.5	1778
1200	924.0	1868

Note: When ADEN (brass cartridges) are used multiply weight and moment by 1.354. When DEFA (steel cartridges) are used multiply by 1.343.

Table 6-9. Aircraft Survivability Equipment Chaff Dispenser and Cartridges

Item	Weight (lb)	Moment (in.-lb/100)
Chaff Dispenser (Empty)	7.2	36
30 Chaff Cartridges	10.0	49
Total Chaff Dispenser + 30 Cartridges (Full)	17.2	85

SECTION VI. CARGO LOADING

6-28. CARGO LOADING.

CAUTION

To prevent damage to helicopter, all cargo must be securely tied down.

There are two stowage compartments on the helicopter. The left aft storage contains the flyaway equipment kit which consists of:

a. Tiedown and mooring kit
b. Main rotor tiedown assembly
c. Main rotor blade tiedown pole assembly
d. Safety pins and stowage pouch
e. Protective covers kit.

The survival kit bay may carry a survival equipment kit and/or personal equipment. The flyaway equipment kit and the survival equipment kit are basic weight items and are listed on Chart A (DD 365-1). Personal items or extra equipment that has not been identified as basic weight must be entered on Form F.

6-29. Extra Cargo.

All extra cargo should be weighed so that exact weight and moments are used for the weight and balance computations. If weighing facilities are not available, weight should be estimated in terms of probable maximum weight to reduce the possibility of exceeding the aft cg limit.

NOTE

All calculated moments must be divided by 100 before being entered on Form F.

Table 6-10. Stowage Bay and Survival Kit Bay Equipment

Left Aft Stowage Bay		Survival Kit Bay	
Accum. Wt. (lb)	Moment (in.-lb/100)	Accum. Wt. (lb)	Moment (in.-lb/100)
5	19	5	16
15	43	15	47
30	86	30	95
45	129	45	142
50	149	50	164
65	194	65	213
80	238	80	262
90	268	90	279
95	292	95	320
110	338	*100	337
*120	368		
Max. Load 120 lb. @ 15 lb/ft^2		Max. Load 100 lb. @ 15 lb/ft^2	

SECTION VII. ALLOWABLE LOADING

6-30. ALLOWABLE LOADING.

This section contains information needed to determine whether the helicopter loading (gross weight and moment combination) will fall within the helicopter center of gravity limits.

6-31. Center of Gravity Limits Chart.

a. The normal forward cg limit is at fuselage station 201.0 inches to 19,400 pounds and a straight taper from 201.0 to 201.9 inches from 19,400 to 20,600 pounds. The normal aft cg limit is at fuse-lage station 207.0 inches to 14,660 pounds and a straight taper from 207.0 to 203.7 inches from 14,660 to 20,600 pounds.

b. The normal center of gravity limits chart is shown in figure 6-5. All flight cg's must remain within these limits. This chart is used in conjunction with Chart F (DD 365-4) as follows:

(1) Load the helicopter to takeoff condition and determine takeoff cg (Form F).

(2) Check cg limits using the chart (figure 6-5). If cg limits are exceeded, then the loading must be revised. Refer to paragraph 6-13 for guidance.

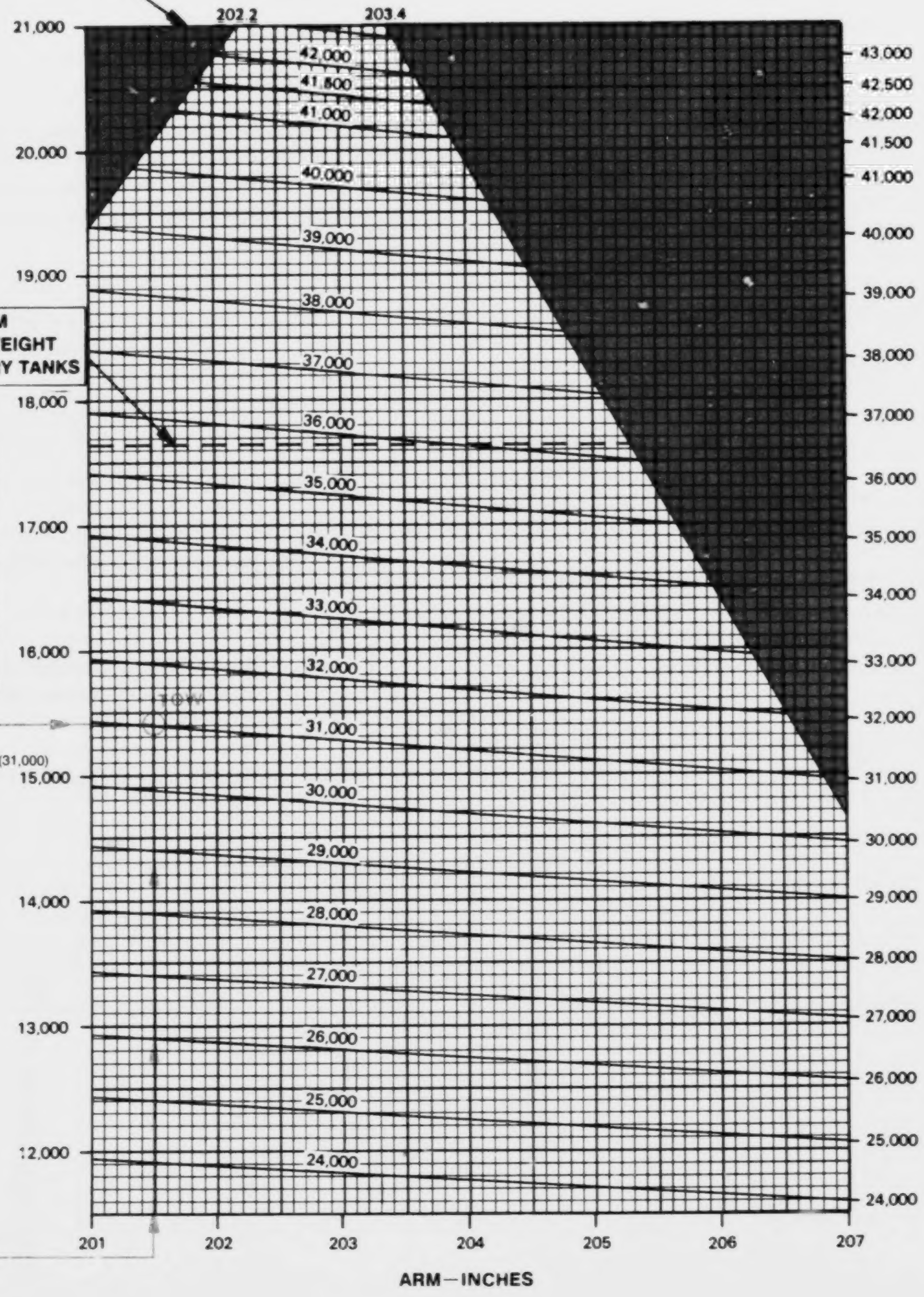
(3) After the takeoff cg limits are satisfied, determine estimated landing weight and cg (Form F).

(4) Check cg limits using the chart (figure 6-5). If cg limits are exceeded, the loading must be revised. Refer to paragraph 6-13 for guidance.

(5) When either takeoff or landing cg is close to the cg limits, further analysis is required to determine if intermediate flight conditions will exceed limits. Refer to paragraph 6-13 for guidance.

NORMAL LONGITUDINAL CENTER OF GRAVITY LIMITS

21,000 LB ALLOWABLE MAXIMUM GROSS WEIGHT WITH AUXILIARY TANKS



17,650 LB MAXIMUM MISSION GROSS WEIGHT WITHOUT AUXILIARY TANKS

EXAMPLE

WANTED

DETERMINE IF LOADING LIMITS ARE EXCEEDED AND FIND C.G. POSITION

KNOWN

G.W. = 15,385 LBS

MOMENT/100 = 31,000

CG = 201.5

METHOD

ENTER GROSS G.W. WEIGHT HERE

MOVE RIGHT TO MOMENT (31,000)
MOVE DOWN READ C.G. 201.5.

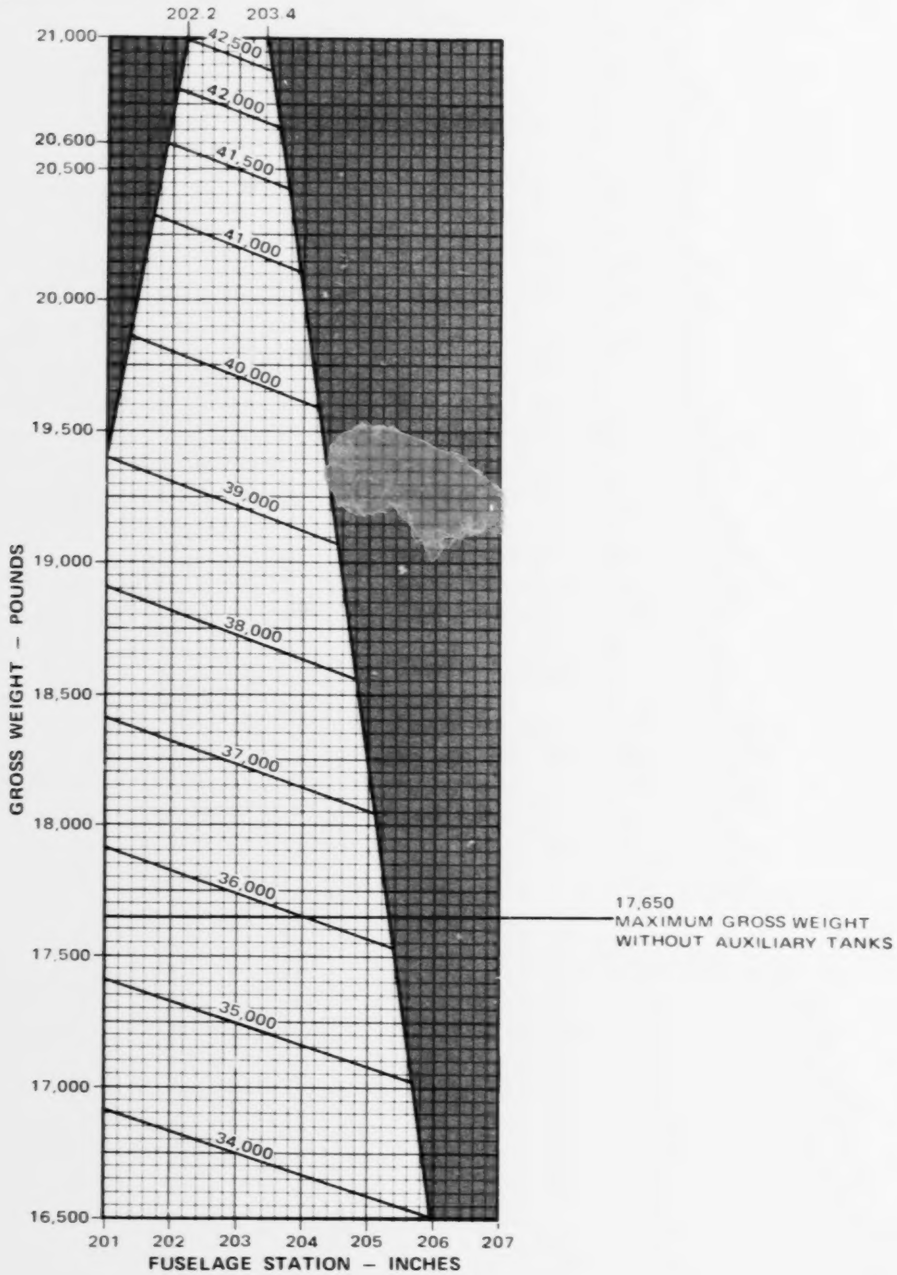
ENTER ARM HERE

■ R ▨ G

MM01-208 C

R

NORMAL LONGITUDINAL CENTER-OF-GRAVITY LIMITS



R

MM01-180C

Figure 6-5. Center of Gravity Limits (Sheet 2 of 2)

CHAPTER 7

PERFORMANCE DATA

Section I. INTRODUCTION

7-1. PERFORMANCE DATA.

The purpose of this chapter is to provide the best available performance data for the AH-64A helicopter. Regular use of this information will allow maximum safe use of the helicopter. Although maximum performance is not always required, regular use of the information in this chapter is recommended for the following reasons:

a. Knowledge of performance margins will allow better decisions when unexpected conditions or alternate missions are encountered.

b. Situations requiring maximum performance will be more readily recognized.

c. Familiarity with the data will allow performance to be computed more easily and quickly.

d. Experience will be gained in accurately estimating the effects of conditions for which data is not presented

NOTE

The information is primarily intended for mission planning and is most useful when planning operations in unfamiliar areas or at extreme conditions. The data may also be used in flight, to establish unit or area standing operating procedures, and to inform ground commanders of performance/risk tradeoffs.

7-2. Chapter 7 Index.

The following index for Chapter 7 lists the sections and their titles, figure numbers, subjects, and page numbers of each performance data chart contained in this chapter

Chapter 7 Index

Section	Subject	Page No.
I	Introduction	7-1
	Figure 7-1. Temperature Conversion Chart	7-7
II	Maximum Torque Available – 30-Minute Limit	7-8
	Figure 7-2. Maximum Torque Available Chart	7-9
III	Hover Ceiling	7-10
	Figure 7-3. Hover Ceiling Chart	7-11
IV	Hover	7-12
	Figure 7-4. Hover Chart	7-13
V	Takeoff	7-14
	Figure 7-5. Takeoff Chart	7-15
VI	Cruise	7-16
	Figure 7-6. Cruise Chart, Example	7-17
	Figure 7-7. Cruise Chart, Sea Level, +10°C Example	7-18
	Figure 7-8. Cruise Chart, Seal Level, -50°C	7-20
	Figure 7-9. Cruise Chart, Sea Level, -40° and -30°C	7-21
	Figure 7-10. Cruise Chart, Sea Level, -20° and -10°C	7-22
	Figure 7-11. Cruise Chart, Sea Level, 0° and +10°C	7-23
	Figure 7-12. Cruise Chart, Sea Level, +20° and +30°C	7-24
	Figure 7-13. Cruise Chart, Sea Level, +40° and +50°C	7-25
	Figure 7-14. Cruise Chart, Sea Level, +60°C	7-26
	Figure 7-15. Cruise Chart, 2,000 Feet -50°C	7-27
	Figure 7-16. Cruise Chart, 2,000 Feet, -40° and -30°C	7-28
	Figure 7-17. Cruise Chart, 2,000 Feet, -20° and -10°C	7-29
	Figure 7-18. Cruise Chart, 2,000 Feet, 0° and +10°C	7-30
	Figure 7-19. Cruise Chart, 2,000 Feet, +20° and +30°C	7-31

Chapter 7 Index (cont)

Section	Subject	Page No.
Figure 7-20.	Cruise Chart, 2,000 Feet, +40° and +50°C	7-32
Figure 2-21.	Cruise Chart, 2,000 Feet, +60°C	7-33
Figure 7-22.	Cruise Chart, 4,000 Feet, -50°C	7-34
Figure 7-23.	Cruise Chart, 4,000 Feet, -40° and -30°C	7-35
Figure 7-24.	Cruise Chart, 4,000 Feet, -20° and -10°C	7-36
Figure 7-25.	Cruise Chart, 4,000 Feet, 0° and +10°C	7-37
Figure 7-26.	Cruise Chart, 4,000 Feet, +20° and +30°C	7-38
Figure 7-27.	Cruise Chart, 4,000 Feet, +40° and +50°C	7-39
Figure 7-28.	Cruise Chart, 4,000 Feet, +60°C	7-40
Figure 7-29.	Cruise Chart, 6,000 Feet, -50° and -40°C	7-41
Figure 7-30.	Cruise Chart, 6,000 Feet, -30° and -20°C	7-42
Figure 7-31.	Cruise Chart, 6,000 Feet, -10° and 0°C	7-43
Figure 7-32.	Cruise Chart, 6,000 Feet, +10° and +20°C	7-44
Figure 7-33.	Cruise Chart, 6,000 Feet, +30° and +40°C	7-45
Figure 7-34.	Cruise Chart, 8,000 Feet, -50° and -40°C	7-46
Figure 7-35.	Cruise Chart, 8,000 Feet, -30° and -20°C	7-47
Figure 7-36.	Cruise Chart, 8,000 Feet, -10° and 0°C	7-48
Figure 7-37.	Cruise Chart, 8,000 Feet, +10° and +20°C	7-49
Figure 7-38.	Cruise Chart, 8,000 Feet, +30° and +40°C	7-50
Figure 7-39.	Cruise Chart, 10,000 Feet, -50° and -40°C	7-51
Figure 7-40.	Cruise Chart, 10,000 Feet, -30° and -20°C	7-52
Figure 7-41.	Cruise Chart, 10,000 Feet, -10° and 0°C	7-53
Figure 7-42.	Cruise Chart, 10,000 Feet, +10° and +20°C	7-54
Figure 7-43.	Cruise Chart, 10,000 Feet, +30°C	7-55
Figure 7-44.	Cruise Chart, 10,000 Feet, +40°C	7-56

Chapter 7 Index (cont)

Section	Subject	Page No.
	Figure 7-45. Cruise Chart, 12,000 Feet, -50° and -40°C	7-57
	Figure 7-46. Cruise Chart, 12,000 Feet, -30° and -20°C	7-58
	Figure 7-47. Cruise Chart, 12,000 Feet, -10° and 0°C	7-59
	Figure 7-48. Cruise Chart, 12,000 Feet, +10° and +20°C	7-60
	Figure 7-49. Cruise Chart, 12,000 Feet, +30°C	7-61
	Figure 7-50. Cruise Chart, 14,000 Feet, -50° and -40°C	7-62
	Figure 7-51. Cruise Chart, 14,000 Feet, -30° and -20°C	7-63
	Figure 7-52. Cruise Chart, 14,000 Feet, -10° and 0°C	7-64
	Figure 7-53. Cruise Chart, 14,000 Feet, +10° and +20°C	7-65
	Figure 7-54. Cruise Chart, 14,000 Feet, +30°C	7-66
	Figure 7-55. Cruise Chart, 16,000 Feet, -50° and -40°C	7-67
	Figure 7-56. Cruise Chart, 16,000 Feet, -30° and -20°C	7-68
	Figure 7-57. Cruise Chart, 16,000 Feet, -10° and 0°C	7-69
	Figure 7-58. Cruise Chart, 16,000 Feet, +10°C	7-70
	Figure 7-59. Cruise Chart, 16,000 Feet, +20°C	7-71
VII	Drag	7-72
	Figure 7-60. Drag Chart and Authorized Armament Configurations	7-73
VIII	Climb-Descent	7-74
	Figure 7-61. Climb-Descent Chart	7-75
IX	Climb Performance	7-76
	Figure 7-62. Climb Performance Chart, Maximum Torque	7-77
	Figure 7-63. Climb Performance Chart, Continuous Torque	7-78
X	Ground Fuel Flow	7-79
	Figure 7-64. Ground Fuel-Flow Chart	7-80

7-3 PERFORMANCE DATA – GENERAL.

The data presented covers the maximum range of conditions and performance that can reasonably be expected. In each area of performance, the effects of altitude, temperature, gross weight, and other parameters relating to that phase of flight are presented. In addition to the presented data, judgment and experience will be necessary to accurately determine performance under a given set of circumstances. The conditions for the data are listed under the title of each chart. The effects of different conditions are discussed in the text accompanying each phase of performance. Where practical, data are presented at conservative conditions. However, NO GENERAL CONSERVATISM HAS BEEN APPLIED.

CAUTION

Exceeding operating limits can cause permanent damage to critical components. Overlimit operation can decrease performance, cause immediate failure, or failure on a subsequent flight.

7-4. Limits.

Applicable limits are shown on the charts as red lines. Performance generally deteriorates rapidly beyond limits. If limits are exceeded, minimize the amount and time. Enter the maximum value and time beyond limits on DA Form 2408-13 so proper maintenance action can be taken.

7-5. Use of Charts.

a. **Chart Explanation**. The first page of each section describes the chart or charts in that section, and explains how each chart is used.

b. **Coding**. Color codes used on the charts are as follows:

(1) **Green** is used for example guidelines.

(2) **Red** is used for limit lines.

(3) **Yellow** is used for precautionary or time-limited operation.

c. **Reading the Charts**. The primary use of each chart is given in an example and a green guideline is provided to help you follow the route through the chart. The use of a straight edge (ruler or page edge) and a hard fine-point pencil is recommended to avoid cumulative errors. The majority of the charts provide a standard pattern for use as follows: Enter first variable on top left scale, move right to second variable, deflect down at right angles to third variable, deflect left at right angles to fourth variable, and deflect down, etc, until final variable is read out at final scale. In addition to the primary use, other uses of each chart are explained in the text accompanying each set of performance charts. Colored registration blocks on the bottom and top of each chart are used to determine if slippage has occurred during printing. Letter codes (G, green; R, red. and Y, yellow) adjacent to the upper or lower registration blocks are used to indicate whether the colors have been printed in their intended positions. If slippage has occurred, or if colors are printed incorrectly, you can find the correct operating limits in Chapter 5. Abbreviations and symbols used in the charts are listed in Appendix B.

NOTE

An example of an auxiliary use of the performance charts follows: Although the hover chart is primarily arranged to find torque required to hover, maximum wheel height for hover can also be found by entering torque available as torque required. In general, any single variable can be found if all others are known. Also, the tradeoffs between two variables can be found. For example, at a given density altitude and pressure altitude, you can find the maximum gross weight capability as free air temperature changes.

7-6. Specific Conditions.

The data presented is accurate only for specific conditions listed under the title of each chart. Variables for which data is not presented, but which may affect that phase of performance, are discussed in the text. Where data is available or reasonable estimates can be made, the amount that each variable affects performance is given.

7-7. General Conditions.

In addition to the specific conditions, the following general conditions are applicable to the performance data:

a. **Rigging**. All airframe and engine controls are assumed to be rigged within allowable tolerances.

b. **Pilot Technique**. Normal pilot technique is assumed. Control movements should be smooth and continuous.

c. **Aircraft Variation**. Variations in performance between individual helicopters are known to exist; they are considered small, however, and cannot be individually accounted for.

d. **Instrument Variation**. The data shown in the performance charts does not account for instrument inaccuracies or malfunctions.

e. **Configuration**. Except as otherwise noted, all data is for the primary mission configuration consisting of the basic helicopter plus a pylon and a fully loaded Hellfire missile launcher on each inboard stores station, no pylons or stores on outboard stations.

7-8. Performance Discrepancies.

Regular use of this chapter will also allow monitoring instruments and other helicopter systems for malfunction, by comparing actual performance with planned performance. Knowledge will also be gained concerning the effects of variables for which data is not provided, thereby increasing the accuracy of performance predictions.

7-9. Temperature Conversion.

A temperature conversion chart is included in the section for the purpose of converting Fahrenheit temperatures to Celsius.

7-10. Abbreviations.

Appendix B is a list of abbreviations and symbols used on the charts in this chapter. For units of measure, the same abbreviation applies to either the singular or plural form of the unit.

G

TEMPERATURE CONVERSION

FAHRENHEIT/CELSIUS

EXAMPLE

WANTED

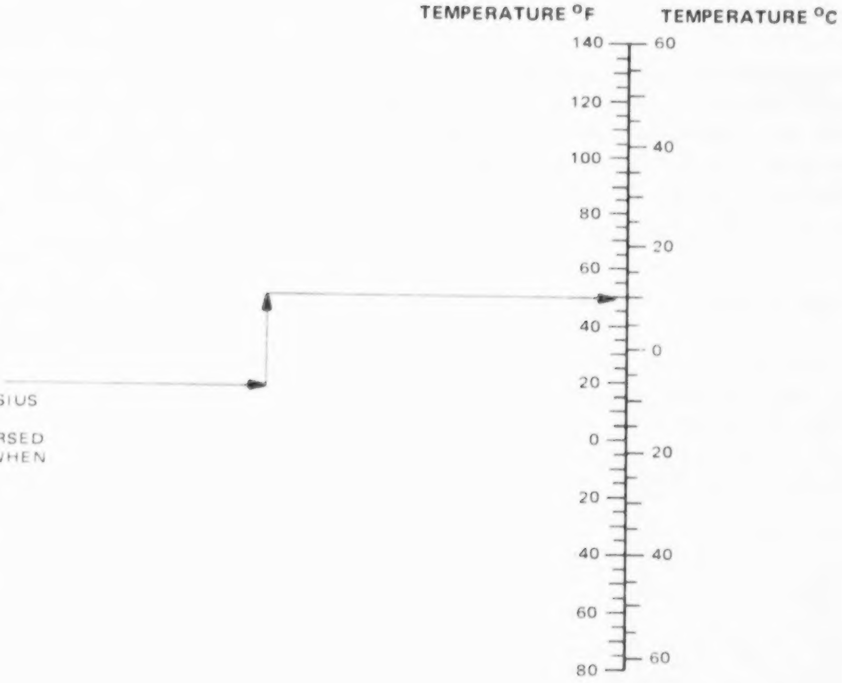
CONVERTED °F TO °C

KNOWN

TEMPERATURE 50°F

METHOD

ENTER FAHRENHEIT
TEMPERATURE AT 50°F
READ CONVERTER CELSIUS
TEMPERATURE = 10°C
METHOD MAY BE REVERSED
TO FIND FAHRENHEIT WHEN
CELSIUS IS KNOWN



G
MM01-076A

Figure 7-1. Temperature Conversion Chart

Section II. MAXIMUM TORQUE AVAILABLE – 30-MINUTE LIMIT

7-11. DESCRIPTION.

The maximum torque available – 30-minute limit chart (figure 7-2) shows the maximum torque available per engine for 30-minute operation at various conditions of pressure altitude and free air temperature. Both single- and dual-engine operation limits are shown.

7-12. Use of Chart.

The primary use of the chart is illustrated by the example. To determine the maximum torque available, 30-minute limit, it is necessary to know pressure altitude and free air temperature. Enter the left side of the chart at the known temperature and move right to the known pressure altitude, and then move down and read maximum torque available, 30-minute limit. This is torque per engine. For dual-engine operation, if the torque per engine exceeds the two-engine limit, the maximum torque available must be reduced to the two-engine limit.

7-13. Conditions.

This chart is based on 100-percent rotor rpm, zero airspeed, JP-4 fuel, and ENG INLET anti-ice switch OFF. With ENG INLET anti-ice switch ON, available torque is reduced by as much as 16 percent. For example, if value from the chart is 90 percent, with anti-ice ON, torque available would be 90 – 16 = 74 percent.

R G

MAXIMUM TORQUE AVAILABLE

30-MIN LIMIT 100% N_R ANTI-ICE OFF

ZERO AIRSPEED

EXAMPLE

WANTED

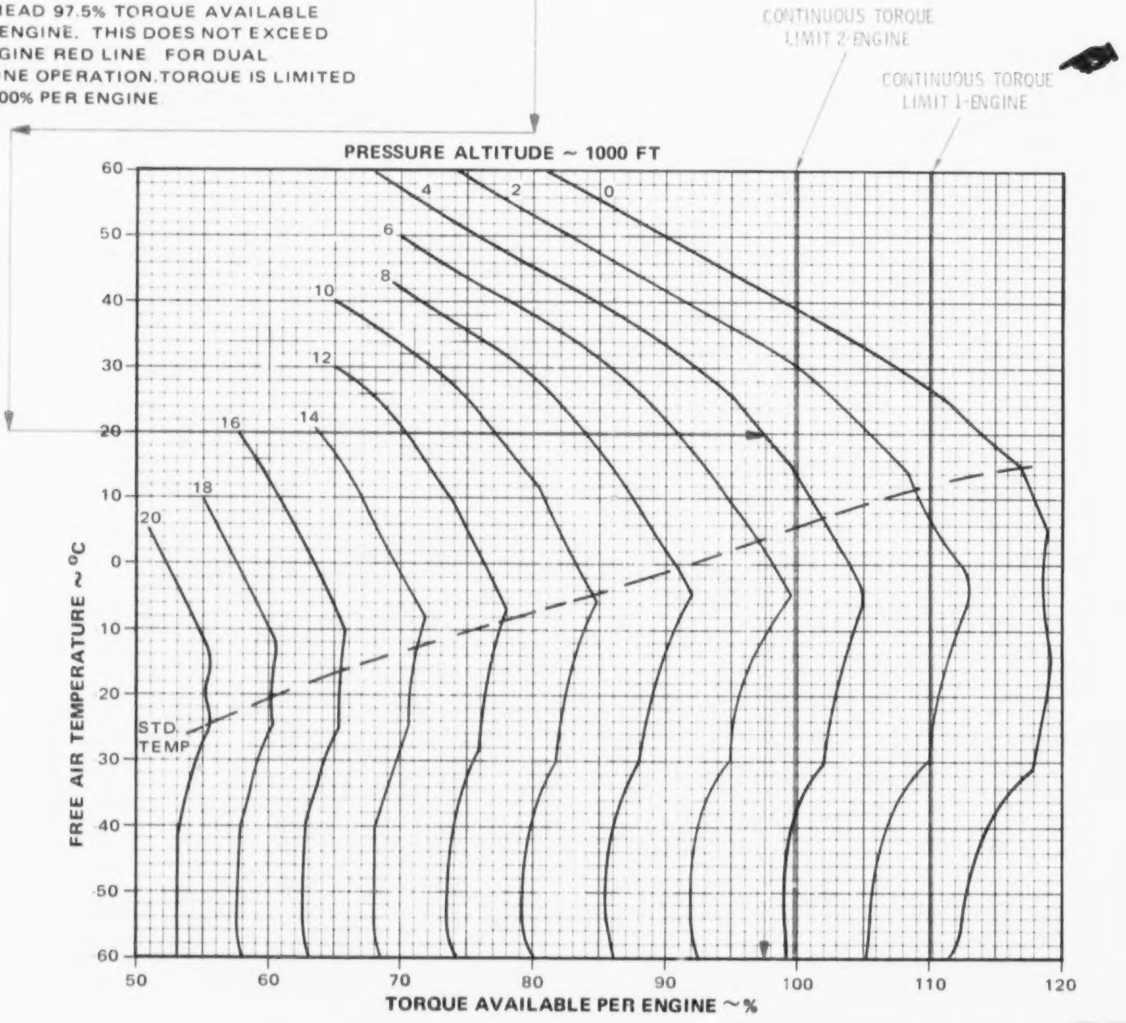
TORQUE AVAILABLE
30-MIN LIMIT.

KNOWN

FAT=+20°C.
PRESSURE ALTITUDE=4000 FT

METHOD

ENTER AT KNOWN FAT=+20°C. MOVE RIGHT TO PRESSURE ALTITUDE = 4000 FT. THEN MOVE DOWN TO READ 97.5% TORQUE AVAILABLE PER ENGINE. THIS DOES NOT EXCEED 2-ENGINE RED LINE. FOR DUAL ENGINE OPERATION, TORQUE IS LIMITED TO 100% PER ENGINE.



R G
MM01-001D

Figure 7-2. Maximum Torque Available Chart – 30-Minute Limit

Section III. HOVER CEILING

7-14. DESCRIPTION.

The hover ceiling chart (figure 7-3) presents the maximum gross weight for hover at various conditions of pressure altitude, free air temperature, and wheel height, using maximum torque available, 30-minute limit.

7-15. Use of Chart.

The primary use of the chart is illustrated by the example. To determine the maximum gross weight for hover, it is necessary to know the pressure altitude, free air temperature, and desired wheel height. Enter the chart at the pressure altitude, move right to FAT, move down to the desired wheel height, and then move left and read maximum gross weight.

7-16. Conditions.

The hover ceiling chart is based on maximum torque available – 30-minute limit, 100-percent rotor rpm, and ENG INLET ANTI-ICE switch OFF. For ENG INLET ANTI-ICE switch ON use dashed lines. Configuration applicable to all external stores except auxiliary fuel tanks.

HOVER CEILING

EXAMPLE I

WANTED

MAXIMUM GROSS WEIGHT FOR HOVER
AT 10-FOOT WHEEL HEIGHT

KNOWN

PRESSURE ALTITUDE = 10,000 FEET
FAT = -10°C
WHEEL HEIGHT = 10 FEET

METHOD

ENTER PRESSURE ALTITUDE SCALE AT 10,000 FT
MOVE RIGHT TO -10°C FAT
MOVE DOWN TO 10 FT WHEEL HEIGHT
MOVE LEFT TO READ GROSS WEIGHT TO
HOVER = 16,470 POUNDS

EXAMPLE II

WANTED

MAXIMUM GROSS WEIGHT FOR HOVER
AT 10-FOOT WHEEL HEIGHT, ENGINE
INLET ANTI-ICE ON

KNOWN

PRESSURE ALTITUDE = 10,000 FEET
FAT = -10°C
WHEEL HEIGHT = 10 FEET

METHOD

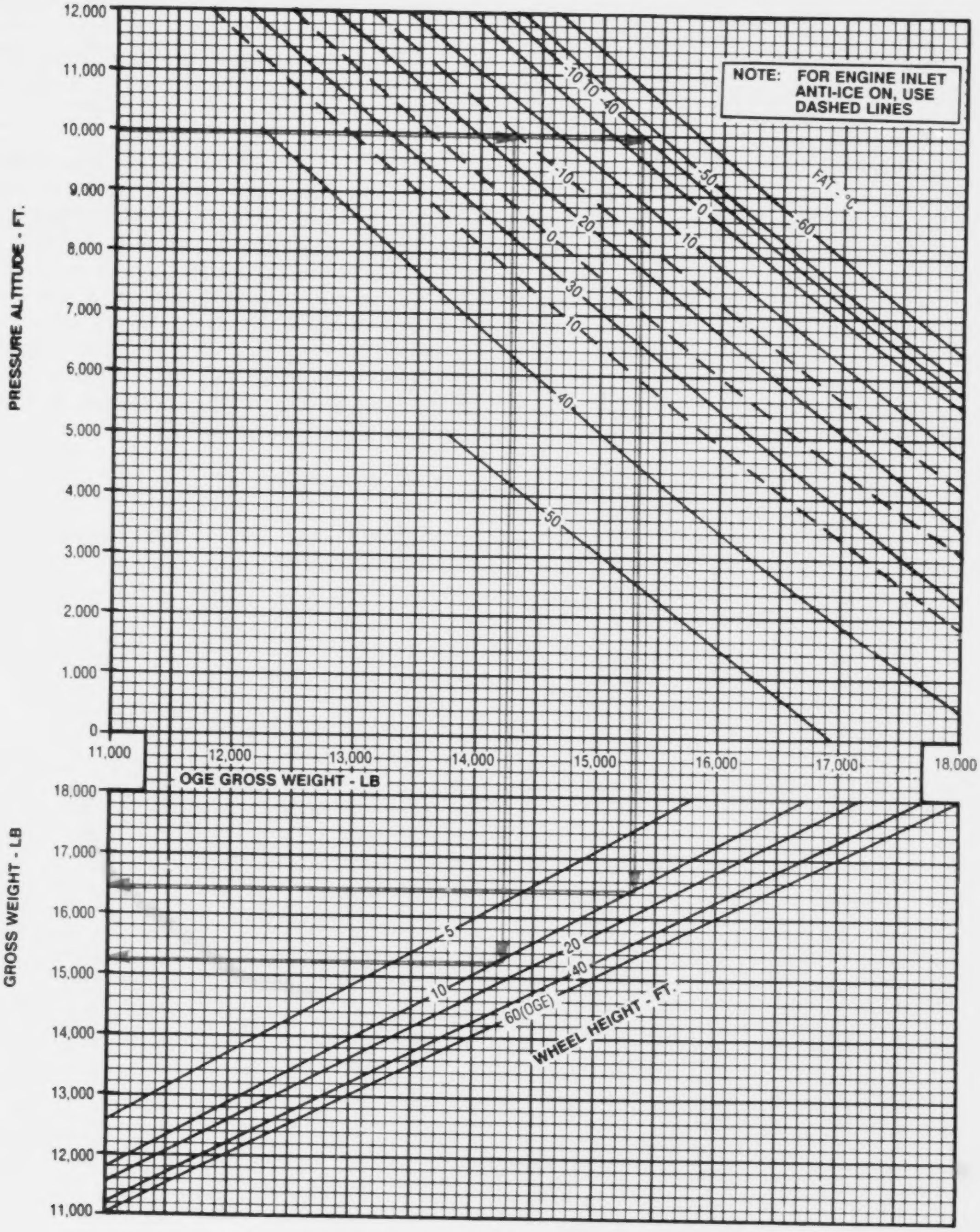
ENTER PRESSURE ALTITUDE SCALE AT 10,000 FT
MOVE RIGHT TO -10°C FAT, DASHED LINE
MOVE DOWN TO 10 FT WHEEL HEIGHT
MOVE LEFT TO READ GROSS WEIGHT TO
HOVER = 15,320 POUNDS

MM01-075-1

G

HOVER HEIGHT
(MAXIMUM GROSS CEILING TO HOVER)

MAXIMUM TORQUE AVAILABLE (30-MIN LIMIT)
100% ROTOR RPM



NOTE: FOR ENGINE INLET ANTI-ICE ON, USE DASHED LINES

Figure 7-3. Hover Ceiling Chart

G

MM01-075-2A

Section IV. HOVER

7-17. DESCRIPTION.

The hover charts (figure 7-4) present the torque required to hover at various conditions of pressure altitude, free air temperature, gross weight, wheel height, and with external tanks or without external tanks.

7-18. Use of Chart.

a. The primary use of the chart is illustrated by the example. To determine the torque required to hover, it is necessary to know the pressure altitude, free air temperature, gross weight, and desired wheel height. Enter the upper right grid at the known pressure altitude, move right to the temperature, move down to the gross weight, move left to the desired wheel height, and then move down and read the torque required to hover.

b. In addition to its primary use, the hover chart may be used to predict the maximum hover height. This capability is needed for use of the takeoff chart. To determine maximum hover height, it is necessary to know pressure altitude, free air temperature, gross weight, and maximum torque available. Enter at the known pressure altitude, move right to the temperature, move down to the gross weight, then move left to intersection with maximum torque available and read wheel height. This wheel height is the maximum hover height.

c. The hover chart may also be used to determine the maximum gross weight for hover at a given wheel height, pressure altitude, and temperature condition. Enter at the known pressure altitude, move right to the temperature, then draw a line down to the bottom of the lower grid. Now enter lower left grid at maximum torque available, move up to wheel height, and then move right to intersect the previously drawn line and read gross weight. This is maximum gross weight at which the helicopter will hover.

7-19. Conditions.

The hover chart is based on calm wind, level surface, and 100-percent rotor rpm.

HOVER—NO EXT. TANKS

ZERO WIND, 100% ROTOR RPM
LEVEL SURFACE

EXAMPLE

WANTED
TORQUE REQUIRED TO HOVER
AT 10 FEET WHEEL HEIGHT

KNOWN
FAT = 20°C
PRESSURE ALTITUDE = 5600 FEET
GROSS WEIGHT = 15,000 POUNDS

METHOD
ENTER CHART AT PRESSURE
ALTITUDE 5600 FEET,
MOVE RIGHT TO FAT = 20°C,
MOVE DOWN TO GROSS WEIGHT = 15,000
POUNDS
MOVE LEFT TO WHEEL HEIGHT
10 FEET, THEN MOVE DOWN
AND READ TORQUE REQUIRED 71.5%

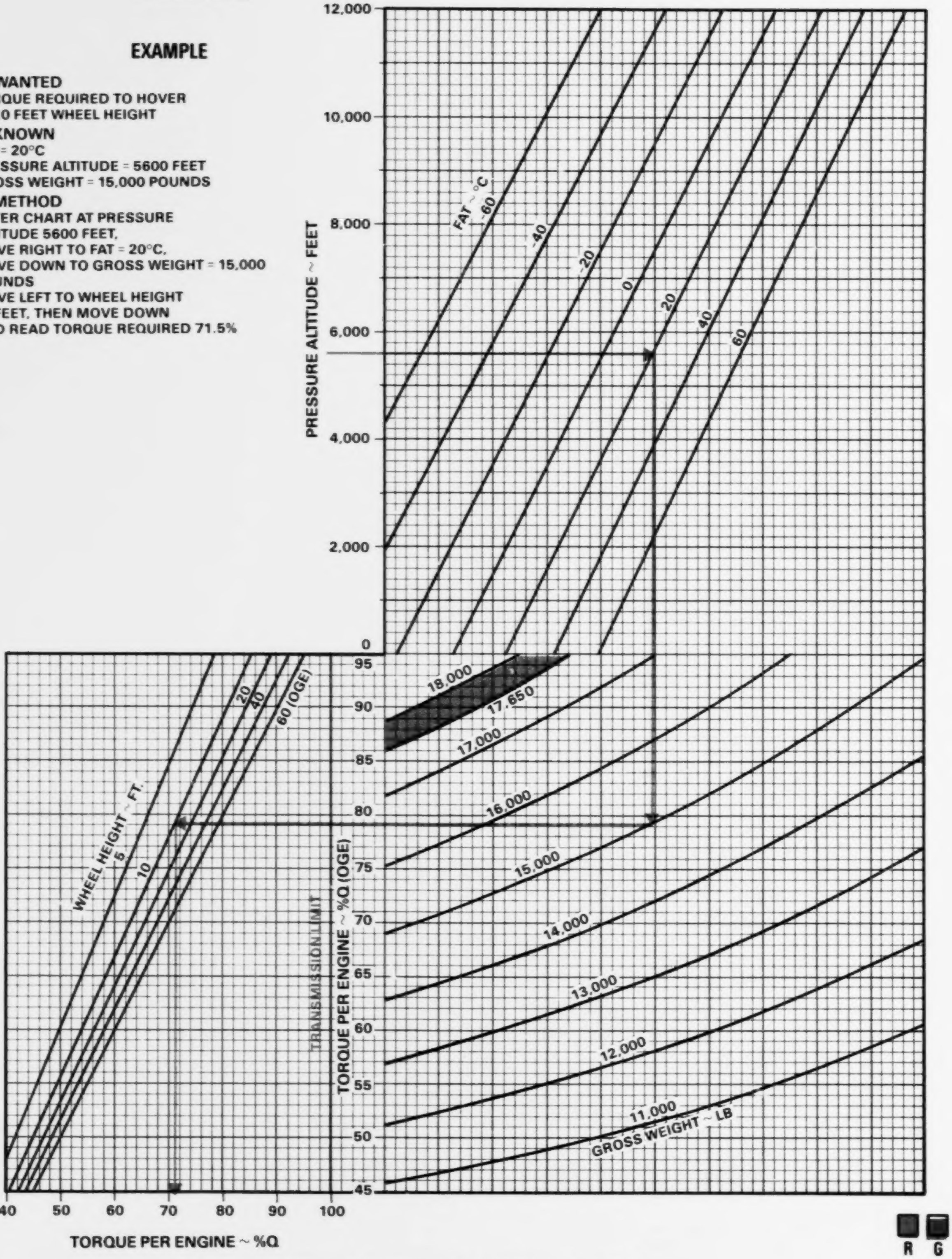


Figure 7-4. Hover Chart (Sheet 1 of 2)

MM01-205

HOVER—EXTERNAL TANKS

ZERO WIND, 100% ROTOR RPM
LEVEL SURFACE

EXAMPLE

WANTED

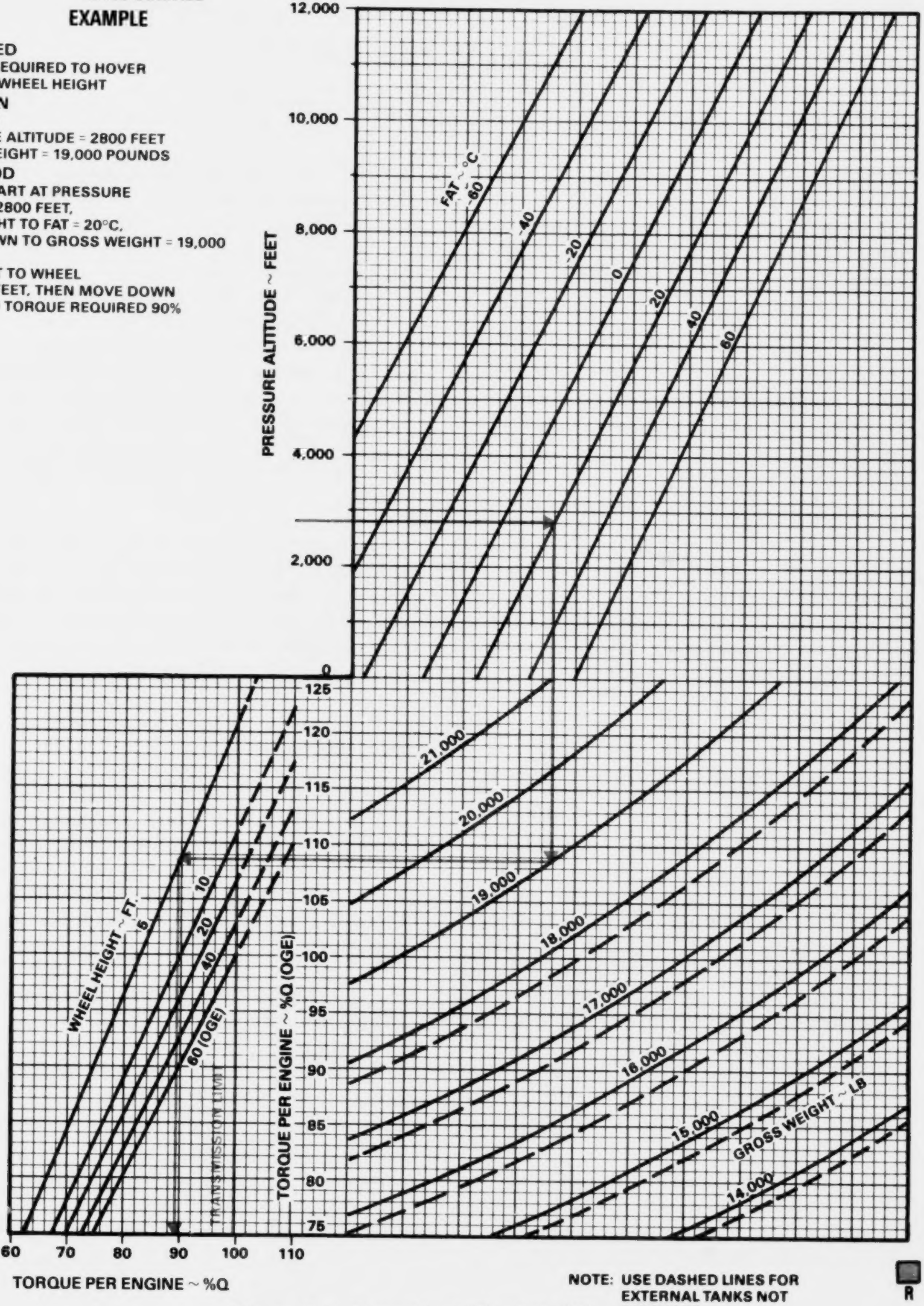
TORQUE REQUIRED TO HOVER AT 5 FEET WHEEL HEIGHT

KNOWN

FAT = 20°C
PRESSURE ALTITUDE = 2800 FEET
GROSS WEIGHT = 19,000 POUNDS

METHOD

ENTER CHART AT PRESSURE ALTITUDE 2800 FEET,
MOVE RIGHT TO FAT = 20°C,
MOVE DOWN TO GROSS WEIGHT = 19,000 POUNDS
MOVE LEFT TO WHEEL HEIGHT 5 FEET, THEN MOVE DOWN AND READ TORQUE REQUIRED 90%



NOTE: USE DASHED LINES FOR EXTERNAL TANKS NOT INSTALLED.

Figure 7-4. Hover Chart (Sheet 2 of 2)

MM01-206

Section V. TAKEOFF

7-20. DESCRIPTION.

The takeoff chart (figure 7-5) shows the distances required to clear various obstacles, based upon maximum hover height capabilities.

NOTE

> The maximum hover heights shown are only a measure of the helicopter's climb capability and do not imply that a higher than 5 foot hover height should be used during the actual takeoff.

7-21. Chart Differences.

The upper chart presents distance required to clear an obstacle for climbout at a constant 50 knot INDICATED airspeed. The lower chart presents distance required to clear an obstacle for climbouts at various TRUE airspeeds.

7-22. Use of Chart.

The primary uses of the chart are illustrated by the examples.

a. To determine the distance required to clear an obstacle at a climbout of 50 knots IAS, it is necessary to know maximum hover height and obstacle height. Calculation of maximum hover height is described in Section IV, Hover. Enter the upper chart at maximum hover height, move right to obstacle height, then down and read distance required to clear obstacle.

b. To determine the distance required to clear an obstacle at various TRUE airspeeds, it is necessary to know maximum hover height, climbout TAS and obstacle height. Calculation of maximum hover height is described in Section IV. Enter the lower chart at maximum hover height, move right to climbout TAS, move down to obstacle height, then left and read distance required to clear obstacle. Additionally, the lower chart may be used to determine the climbout TAS by first determining the maximum hover height. Then enter at the known distance, move right to the obstacle height, then up to the maximum hover height and read climbout TAS.

c. Before takeoff a hover check may be made to verify the hover capability. If winds are present, the hover check may disclose that the helicopter can actually hover at a greater wheel height than the calculated value, since the hover chart is based upon calm wind conditions.

7-23. Conditions.

a. The takeoff chart is based on calm wind conditions. Since the surface wind velocity and direction cannot be accurately predicted, all takeoff planning should be based on calm wind conditions. Takeoff into the wind will improve the takeoff performance.

b. All takeoff performance data are based on the use of maximum torque available.

G Y

TAKEOFF

AT MAXIMUM HOVER CAPABILITY
LEVEL ACCELERATION TECHNIQUE 5 FT WHEEL HEIGHT
ZERO WIND, 30 MIN. LIMIT TORQUE, 100% ROTOR RPM

EXAMPLE A

WANTED

DISTANCE TO CLEAR OBSTACLE

KNOWN

MAXIMUM HOVER HEIGHT = 10 FT
OBSTACLE HEIGHT = 50 FT.

METHOD

ENTER MAXIMUM HOVER HEIGHT HERE
MOVE RIGHT TO OBSTACLE HEIGHT
MOVE DOWN, READ DISTANCE TO CLEAR OBSTACLE = 1090 FT.

EXAMPLE B

WANTED

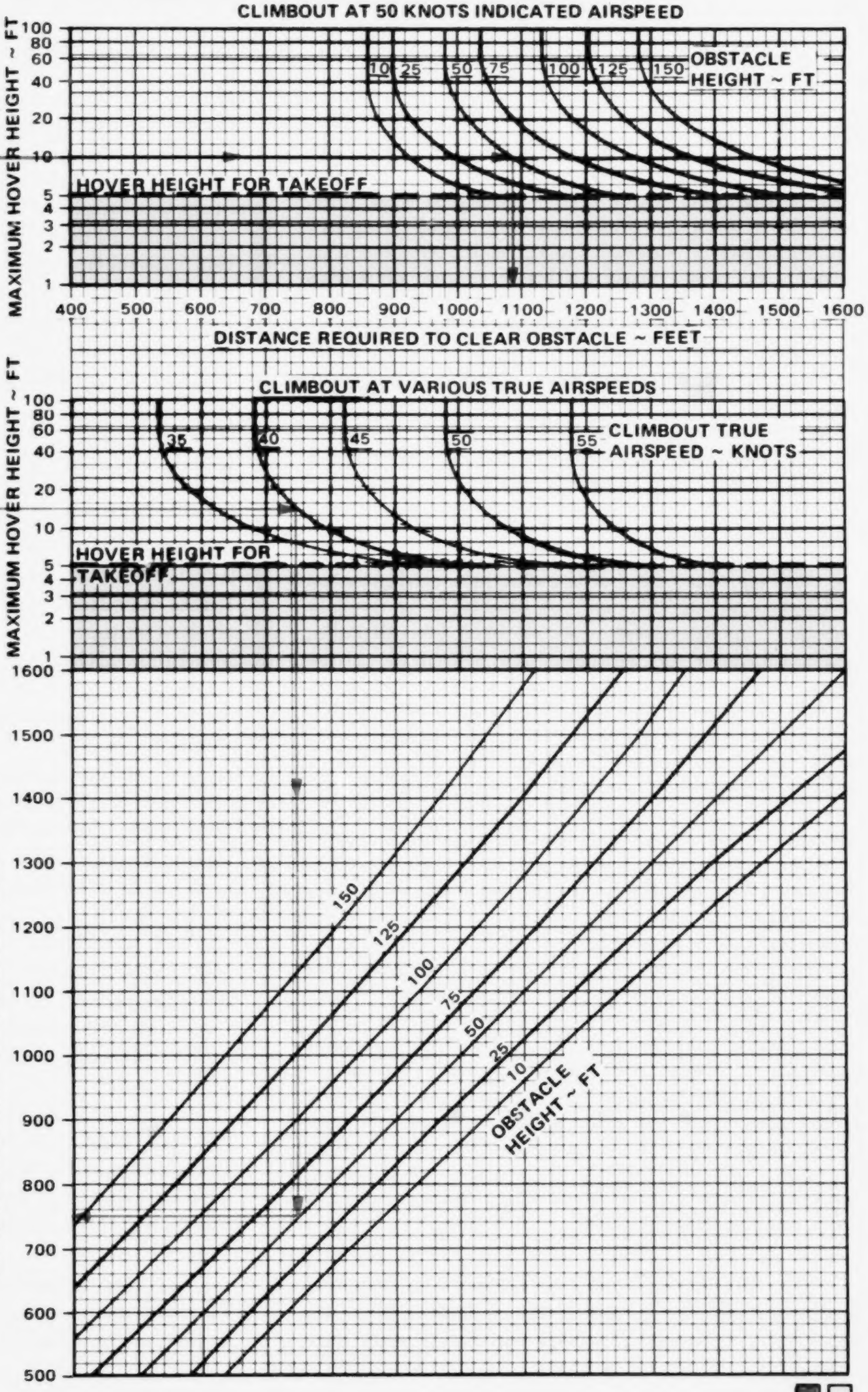
DISTANCE TO CLEAR OBSTACLE

KNOWN

MAXIMUM HOVER HEIGHT = 15 FT
OBSTACLE HEIGHT = 50 FT
CLIMBOUT AIRSPEED = 40 KNOTS

METHOD

ENTER MAXIMUM HOVER HEIGHT HERE
MOVE RIGHT TO CLIMBOUT TRUE AIRSPEED
MOVE DOWN TO OBSTACLE HEIGHT
MOVE LEFT READ DISTANCE TO CLEAR OBSTACLE = 750 FT.



G Y

Figure 7-5. Takeoff Chart

MM01-184

Section VI. CRUISE

7-24. Description.

The cruise charts (figures 7-6 through 7-59) present the level-flight torque required and total fuel flow at various conditions of airspeed, pressure altitude, free air temperature, and gross weight. Cruise charts are provided for pressure altitudes from sea level to 16,000 feet in 2000-foot increments. Free air temperatures range from -50° to +50°C in 10°C increments. In addition to basic cruise information, the charts show speeds for maximum range, maximum endurance, and maximum rate of climb. Change in torque with change in frontal area information is presented in the upper left corner of each chart.

7-25. Use of Charts.

The primary uses of the charts are illustrated by the examples. To use the charts, it is usually necessary to know the planned pressure altitude, estimated free air temperature, planned cruise speed, TAS, and gross weight. First, select the proper chart on the basis of pressure altitude and FAT. Enter the chart at the cruise airspeed, IAS, move right and read TAS, move left to the gross weight, move down and read torque required, and then move up and read associated fuel flow. Maximum performance conditions are determined by entering the chart where the maximum range line or the maximum endurance and rate-of-climb line intersects the gross weight line; then read airspeed, fuel flow, and torque required. Normally, sufficient accuracy can be obtained by selecting the chart nearest the planned cruising altitude and FAT or, more conservatively, by selecting the chart with the next higher altitude and FAT. If greater accuracy is required, inter-polation between altitudes and/or temperatures is permissible. To be conservative, use the gross weight at the beginning of the cruise flight. For greater accuracy on long flights, however, it is preferable to determine cruise information for several flight segments to allow for the decreasing gross weight.

a. **Airspeed**. True and indicated airspeeds are presented at opposite sides of each chart. On any chart, indicated airspeed can be directly converted to true airspeed (or vice versa) by reading directly across the chart without regard for the other chart information. The applicable Mach No. or gross weight maximum permissible air-speed limits (V_{NE}) determined from figure 5-2 appear as red lines on the appropriate charts.

b. **Torque**. Since pressure altitude and temperature are fixed for each chart, torque required varies according to gross weight and airspeed. The torque required and the torque limits shown on these charts are for dual-engine operation. The torque available shown on these charts as black lines are maximum continuous torque available and maximum torque available - 30 minutes. These torque lines are the minimum torque available at the engine turbine gas temperature limits specified in Chapter 5. Higher torque than that represented by these lines may be used if it is available without exceeding the limitations presented in Chapter 5. The limit torque line shown on these charts as a red line is for the dual engine transmission limit and is defined as 100 percent torque. An increase or decrease in torque required because of a drag area change is calculated by adding or subtracting the change in torque from the torque change (ΔQ) curve on the chart, and then reading the new fuel flow total.

c. **Fuel Flow** . Fuel flow scales are provided opposite the torque scales. On any chart, torque may be converted directly to fuel flow without regard to other chart information. Ground fuel flow at flat pitch and 100% N_P is approximately 550 pounds per hour.

d. **Maximum Range**. The maximum range lines indicate the combinations of gross weight and airspeed that will produce the greatest flight range per pound of fuel under zero wind conditions.

e. **Maximum Endurance and Rate of Climb**. The maximum endurance and rate of climb lines indicate the combinations of gross weight and

G R

CRUISE
PRESSURE ALTITUDE – SEA LEVEL
100% RPM, 8 HELLFIRE CONFIGURATION, JP-4 FUEL

FAT = +10°C

EXAMPLE

WANTED

TORQUE REQUIRED AND FUEL FLOW FOR 76 ROCKET CONFIGURATION

KNOWN

PRESSURE ALTITUDE=S.L., FAT=+10 C, GW=14,000 LB, 4 LOADED ROCKET LAUNCHERS (76 ROCKETS), IAS 150 KN

METHOD

FROM DRAG CHART (FIG 7-60) OBTAIN MULTIPLYING FACTOR= -0.41

ENTER CRUISE CHART AT IAS=150 KN

MOVE RIGHT TO BROKEN ΔQ LINE

MOVE UP TO READ ΔQ=12.8%

MULTIPLY ΔQ BY MULTIPLYING FACTOR TO GET CHANGE IN TORQUE=-5.2%

RE-ENTER CRUISE CHART AT IAS=150 KN

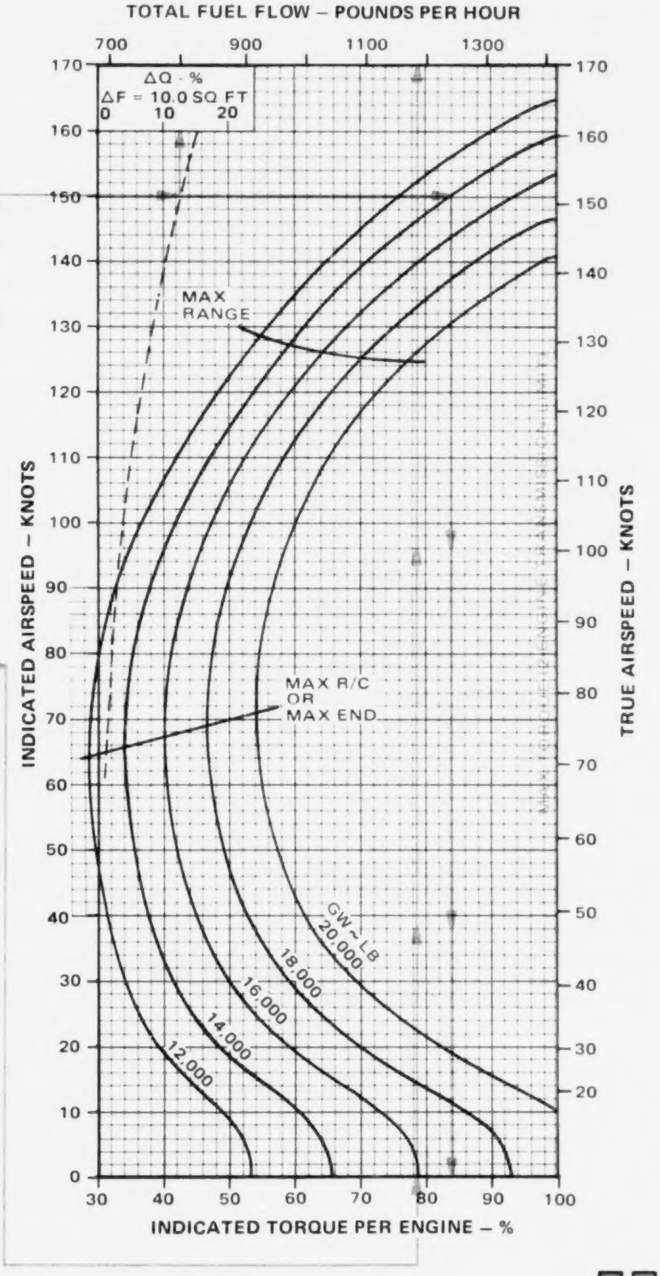
MOVE RIGHT TO GW 14,000 LB

MOVE DOWN AND READ INDICATED TORQUE PER ENGINE=84.2%

TORQUE REQUIRED =84.2-5.2=79.8%

RE-ENTER CRUISE CHART AT 79.8%

MOVE UP AND READ FUEL FLOW=1183 LB/HR



G R

MM01-114A

Figure 7-6. Cruise Chart, Example

G R

CRUISE

PRESSURE ALTITUDE – SEA LEVEL

100% RPM, 8 HELLFIRE CONFIGURATION, JP-4 FUEL

EXAMPLE I

WANTED

TORQUE REQUIRED, AIRSPEED, AND FUEL FLOW FOR MAXIMUM RANGE.

KNOWN

PRESSURE ALTITUDE = SL, FAT = +10°C, AND GROSS WEIGHT = 14,000 POUNDS.

METHOD

AT THE INTERSECTION OF THE MAXIMUM RANGE LINE AND THE 14,000 POUND LINE
MOVE LEFT, READ IAS = 127 KN.
MOVE RIGHT, READ TAS = 130 KN.
MOVE UP, READ TOTAL FUEL FLOW = 970 LB/HR.
MOVE DOWN, READ INDICATED TORQUE/ENGINE = 59%.

EXAMPLE II

WANTED

TORQUE REQUIRED, AIRSPEED, AND FUEL FLOW FOR MAXIMUM ENDURANCE.

KNOWN

PRESSURE ALTITUDE = SL, FAT = +10°C, AND GROSS WEIGHT = 14,000 POUNDS.

METHOD

AT THE INTERSECTION OF THE MAXIMUM ENDURANCE AND THE 14,000 POUND LINE
MOVE LEFT, READ IAS = 66 KN.
MOVE RIGHT, READ TAS = 73 KN.
MOVE UP, READ TOTAL FUEL FLOW = 717 LB/HR.
MOVE DOWN, READ INDICATED TORQUE/ENGINE = 34%

EXAMPLE III

(INTERPOLATION NOT ILLUSTRATED)

WANTED

MAXIMUM ENDURANCE, AIRSPEED, FUEL FLOW, AND TORQUE.

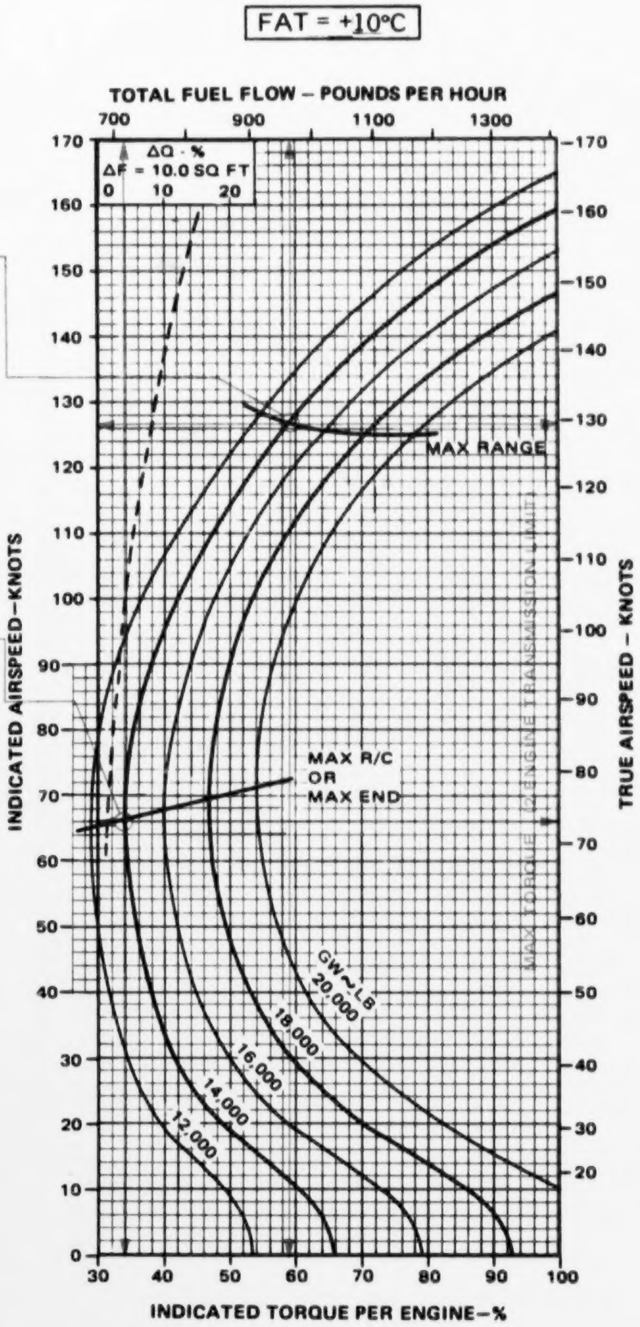
KNOWN

PRESSURE ALTITUDE = 1000 FT, FAT = +15°C, AND GROSS WEIGHT = 14,000 POUNDS.

METHOD

READ AIRSPEED, TORQUE, AND FUEL FLOW FOR EACH ADJACENT ALTITUDE AND FAT, THEN INTERPOLATE BETWEEN FAT AND ALTITUDE AS FOLLOWS:

ALTITUDE	SEA LEVEL		2000 FEET		SOLUTION: 1000 FEET
FAT	20	10	20	10	15
TORQUE	34	34	35	35	34
FUEL FLOW	720	717	700	700	709
IAS	65	66	63	64	64
TAS	73	73	73	73	73



G R

MM01-050B

Figure 7-7. Cruise Chart, Sea Level, + 10°C Example

airspeed that will produce the maximum endurance and the maximum rate of climb. The torque required for level flight at this condition is a minimum, providing a minimum fuel flow (maximum endurance) and a maximum torque change available for climb (maximum rate of climb).

f. **Change in Frontal Area**. Since the cruise information is given for the primary mission configuration, adjustments to torque should be made when operating with alternative wing-stores configurations. To determine the change in torque, first obtain the appropriate multiplying factor from the drag chart (figure 7-60), then enter the cruise chart at the planned cruise speed TAS, move right to the broken ΔQ line, and move up and read ΔQ. Multiply ΔQ by the multiplying factor to obtain change in torque, then add or subtract change in torque from torque required for the primary mission configuration. Enter the cruise chart at resulting torque required, move up, and read fuel flow. If the resulting torque required exceeds the governing torque limit, the torque required must be reduced to the limit. The resulting reduction in airspeed may be found by subtracting the change in torque from the limit torque; then enter the cruise chart at the reduced torque, and move up to the gross weight. Move left or right to read TAS or IAS. To determine the airspeed for maximum range for alternative wing stores configuration, reduce the value from the cruise chart by 2 knots for each 5 square feet increase in drag area, ΔF, or increase maximum range airspeed 2 knots for each 5 square feet reduction in drag area. For example, for the 16 Hellfire configuration $\Delta F = 5.9$ square feet, from figure 7-60. Therefore, maximum range airspeed would be reduced by $2/5 \times 5.9 = 2.36$ knots, or approximately 2.5 knots.

g. **Additional Uses**. The low-speed end of the cruise chart (below 40 knots) is shown primarily to familiarize you with the low-speed power requirements of the helicopter. It shows the power margin available for climb or acceleration during maneuvers, such as NOE flight. At zero airspeed, the torque represents the torque required to hover out of ground effect. In general, mission planning for low-speed flight should be based on hover out of ground effect.

7-26. Conditions.

The cruise charts are based on 100-percent rotor rpm, ENG INLET ANTI-ICE switch OFF, JP-4 fuel, and dual-engine operation. Engine inlet anti-ice and rotor blade de-ice effects are as follows:

(1) With ENG INLET ANTI-ICE switch ON, fuel flow will increase approximately 60 pounds per hour, maximum torque avaliable could be reduced by as much as 16 percent, and maximum continuous torque available could be reduced by as much as 17 percent.

(2) With ROTOR BLADE DE-ICE switch ON, fuel flow will increase approximately 30 pounds per hour, and torque required will increase 1.4 percent.

For example, with ENG INLET ANTI-ICE and ROTOR BLADE DE-ICE OFF, torque required, from the cruise chart is 50 percent, and maximum continuous torque is 92 percent. With ENG INLET ANTI-ICE and ROTOR BLADE DE-ICE ON, torque required will be $50 + 1.4 = 51.4$ percent, and maximum continuous torque will be approximately $92 - 17 = 75$ percent.

CRUISE

PRESSURE ALTITUDE – SEA LEVEL

100% RPM, 8 HELLFIRE CONFIGURATION, JP-4 FUEL

FAT = -50°C

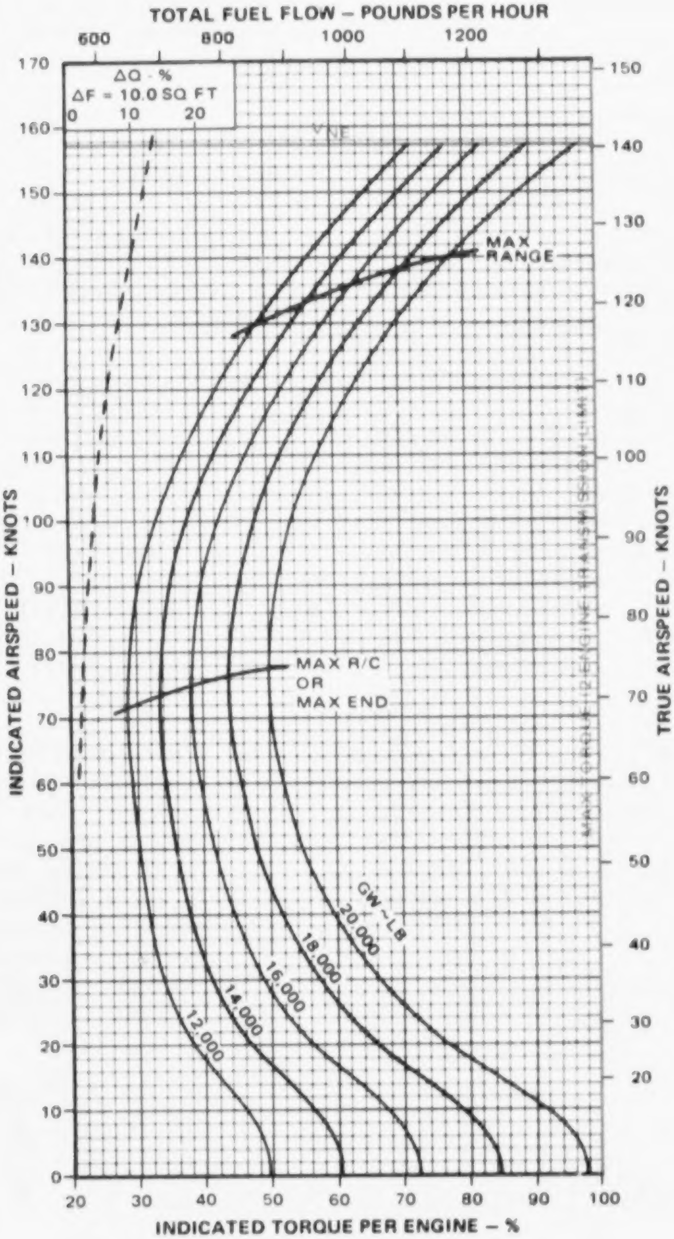
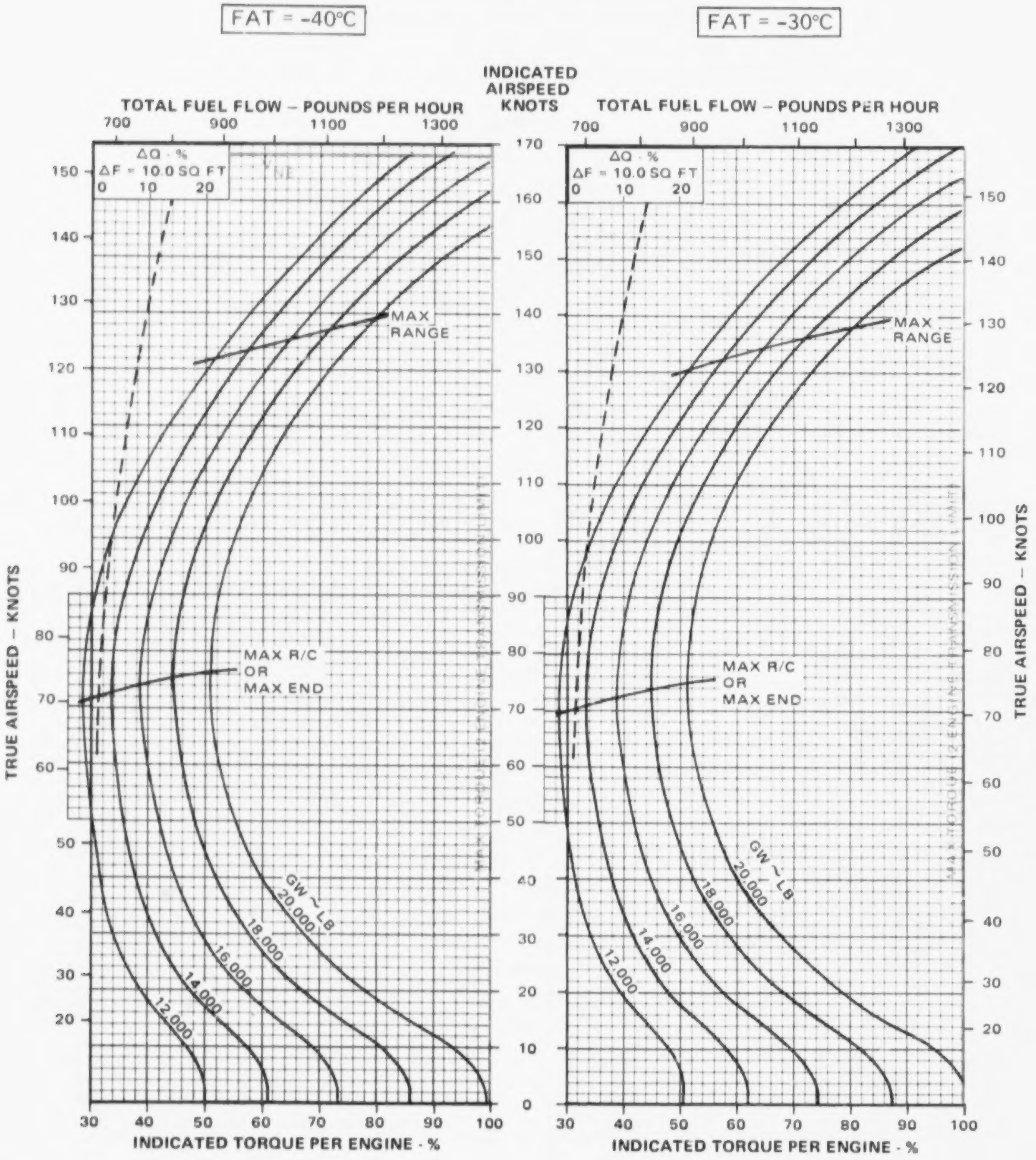


Figure 7-8. Cruise Chart, Sea Level, -50°

CRUISE

PRESSURE ALTITUDE – SEA LEVEL

100% RPM, 8 HELLFIRE CONFIGURATION, JP-4 FUEL



MM01-051B

Figure 7-9. Cruise Chart, Sea Level, -40° and -30°C

CRUISE

PRESSURE ALTITUDE – SEA LEVEL

100% RPM, 8 HELLFIRE CONFIGURATION, JP-4 FUEL

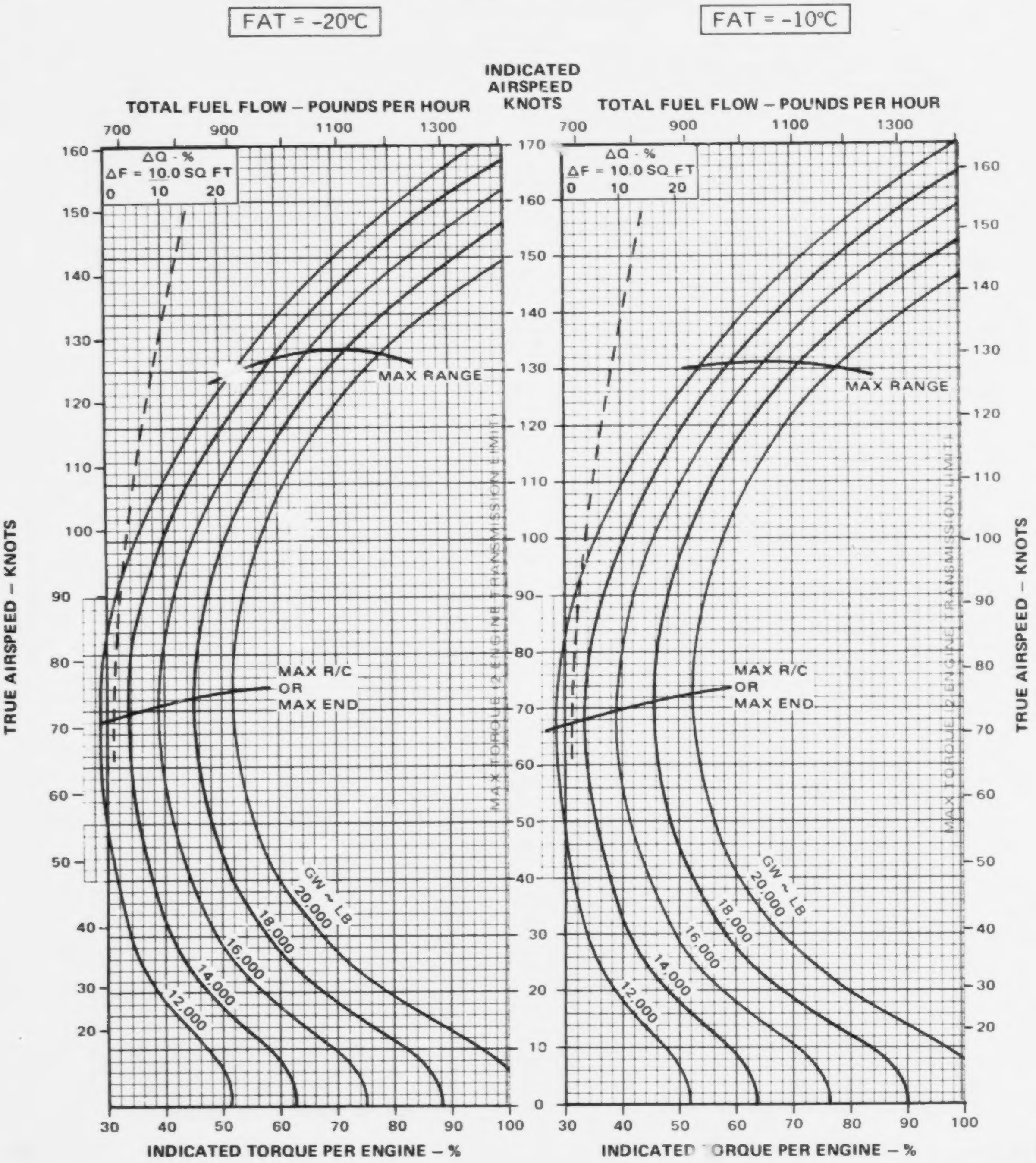


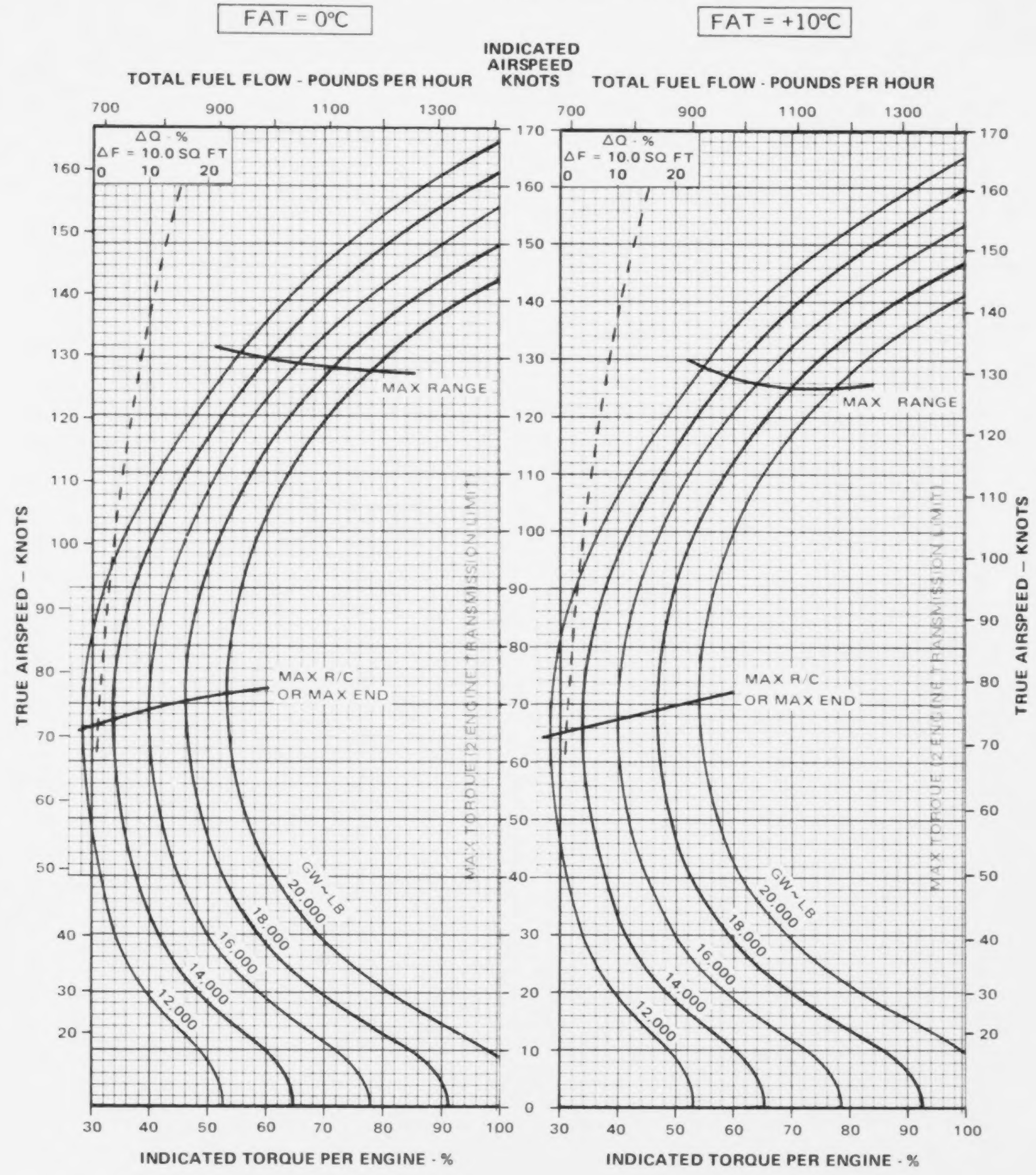
Figure 7-10. Cruise Chart, Sea Level,-20° and -10°C

R

CRUISE

PRESSURE ALTITUDE – SEA LEVEL

100% RPM, 8 HELLFIRE CONFIGURATION, JP-4 FUEL



R

MM01-053B

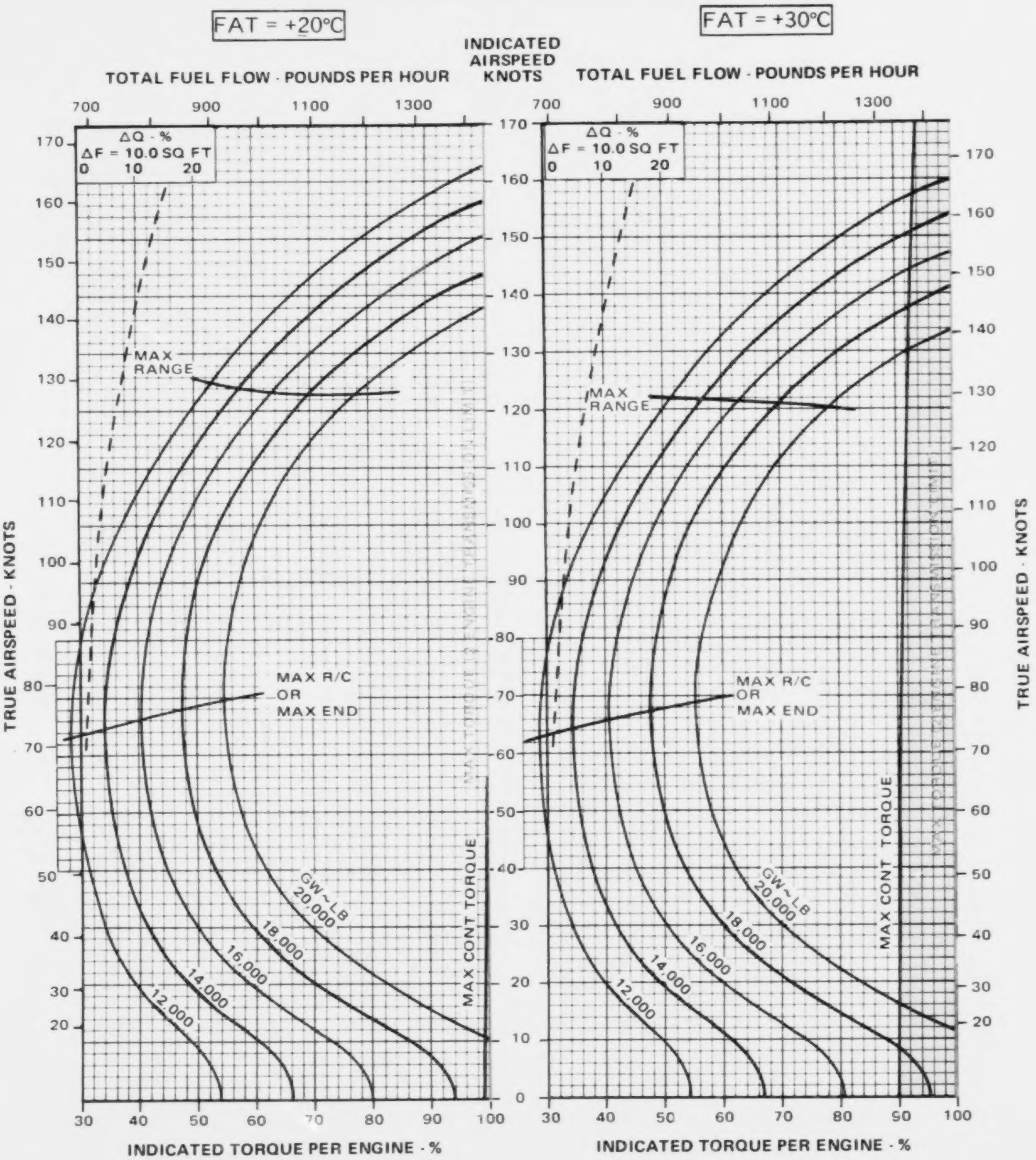
Figure 7-11. Cruise Chart, Sea Level, 0° and + 10°C

▨ ☐
R Y

CRUISE

PRESSURE ALTITUDE – SEA LEVEL

100 % RPM, 8 HELLFIRE CONFIGURATION, JP-4 FUEL



▨ ☐
R Y
MM01-054B

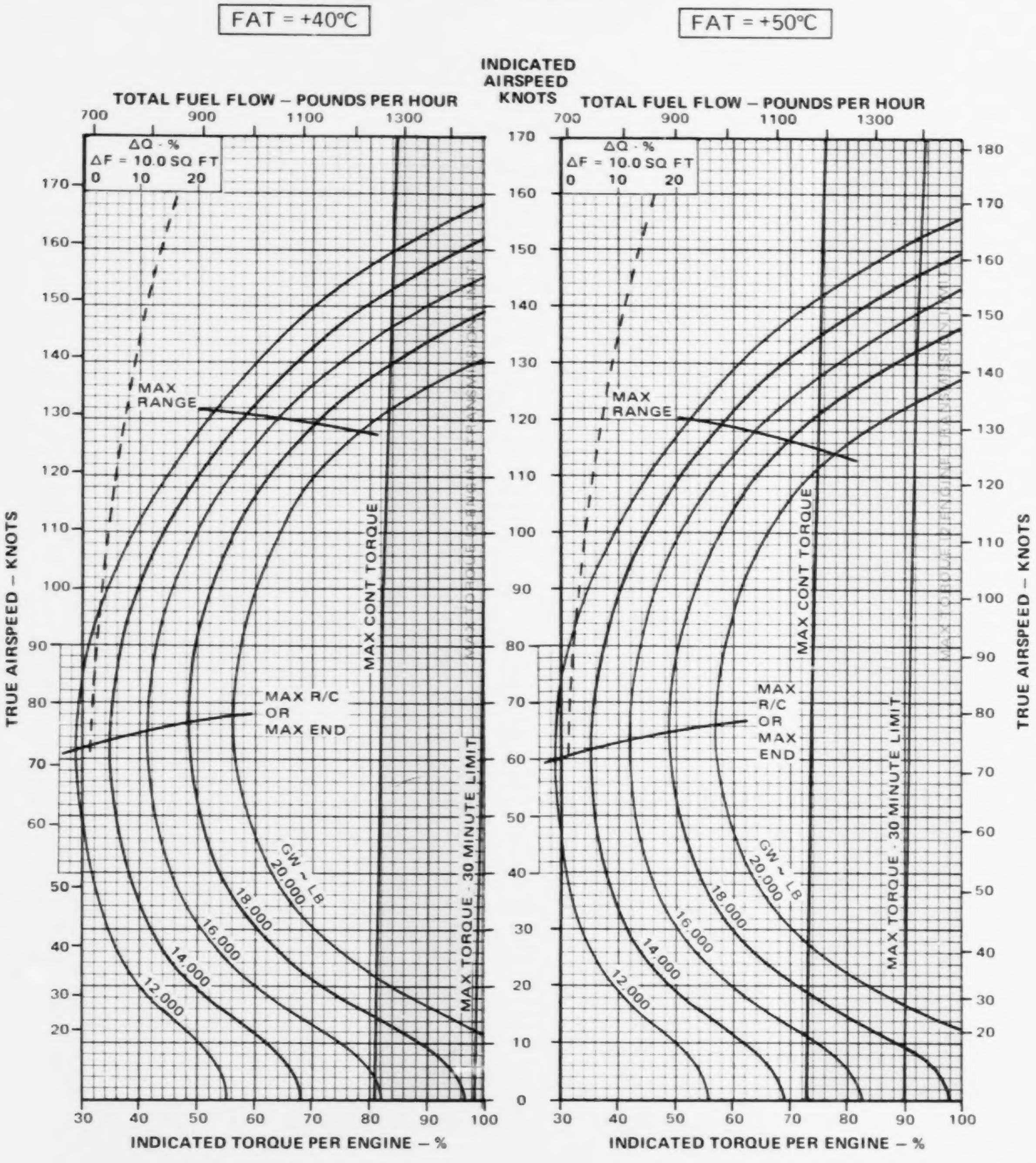
Figure 7-12. Cruise Chart, Sea Level, + 20° and + 30°C

▨ ☐
R Y

CRUISE

PRESSURE ALTITUDE – SEA LEVEL

100% RPM, 8 HELLFIRE CONFIGURATION, JP-4 FUEL



▨ ☐
R Y

MM01-055B

Figure 7-13. Cruise Chart, Sea Level, +40° and +50°C

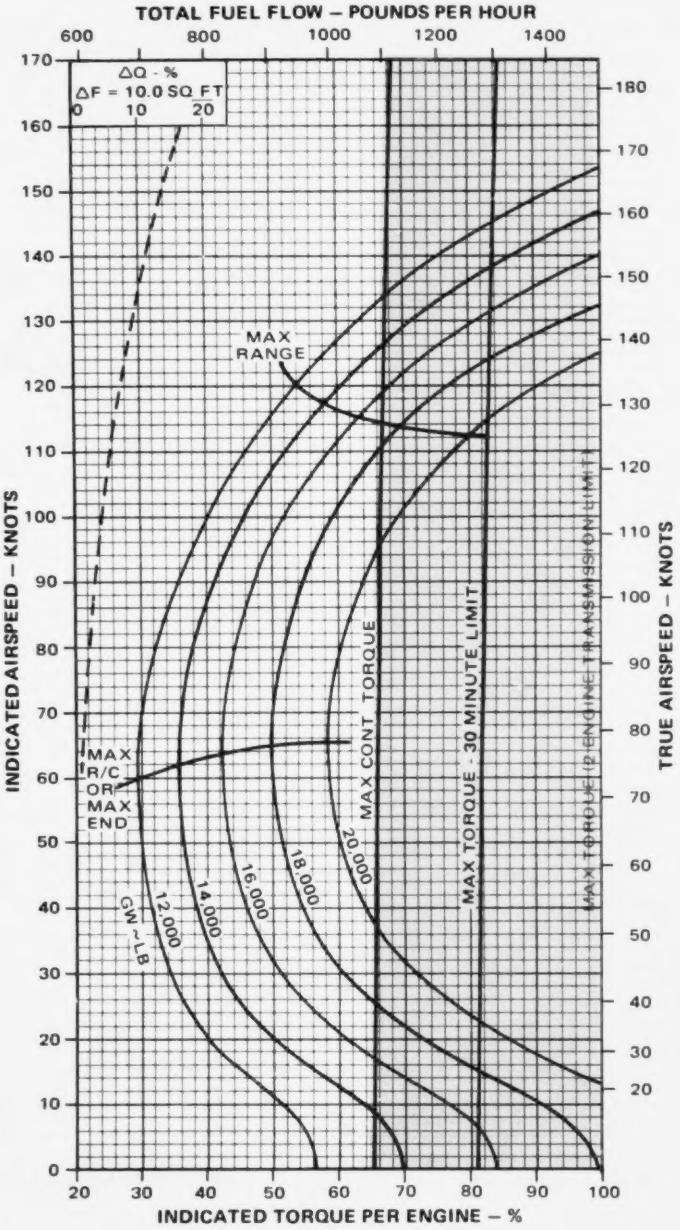
■ ☐
R Y

CRUISE

PRESSURE ALTITUDE – SEA LEVEL

100% RPM, 8 HELLFIRE CONFIGURATION, JP-4 FUEL

FAT = +60°C

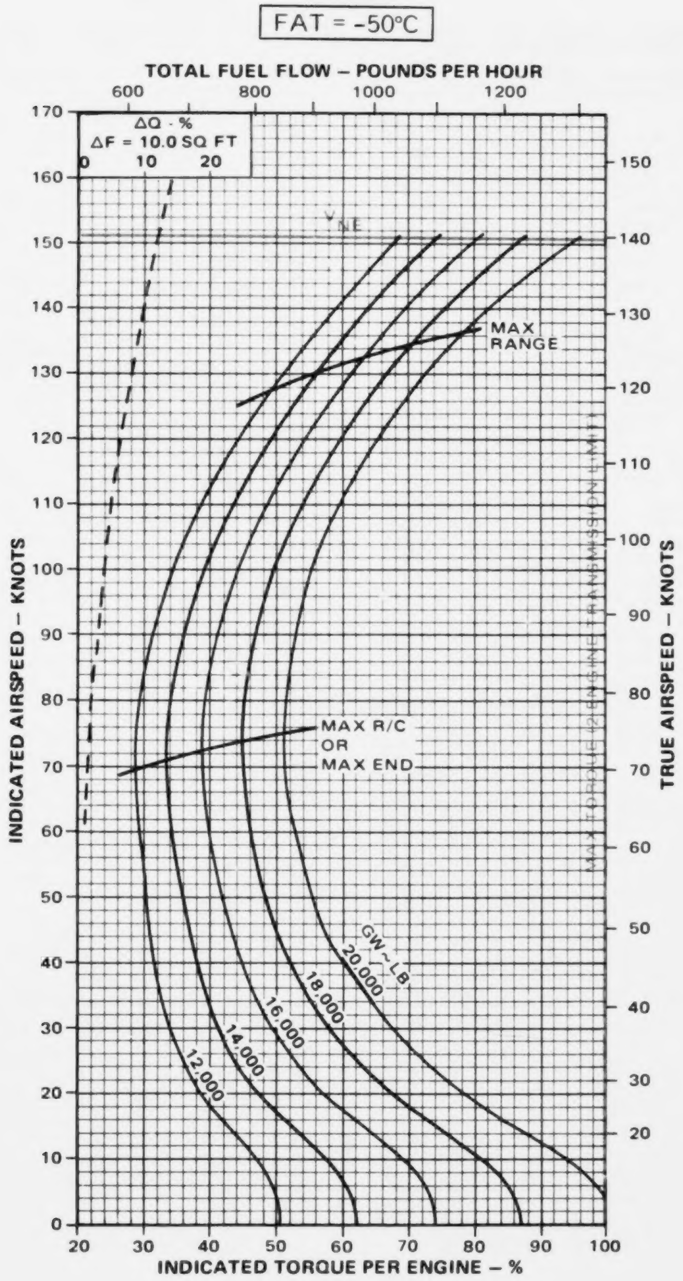


☐ ■
Y R

MM01-202

Figure 7-14. Cruise Chart, Sea Level, + 60°C

CRUISE
PRESSURE ALTITUDE - 2000 FEET
100% RPM, 8 HELLFIRE CONFIGURATION, JP-4 FUEL



MM01-195

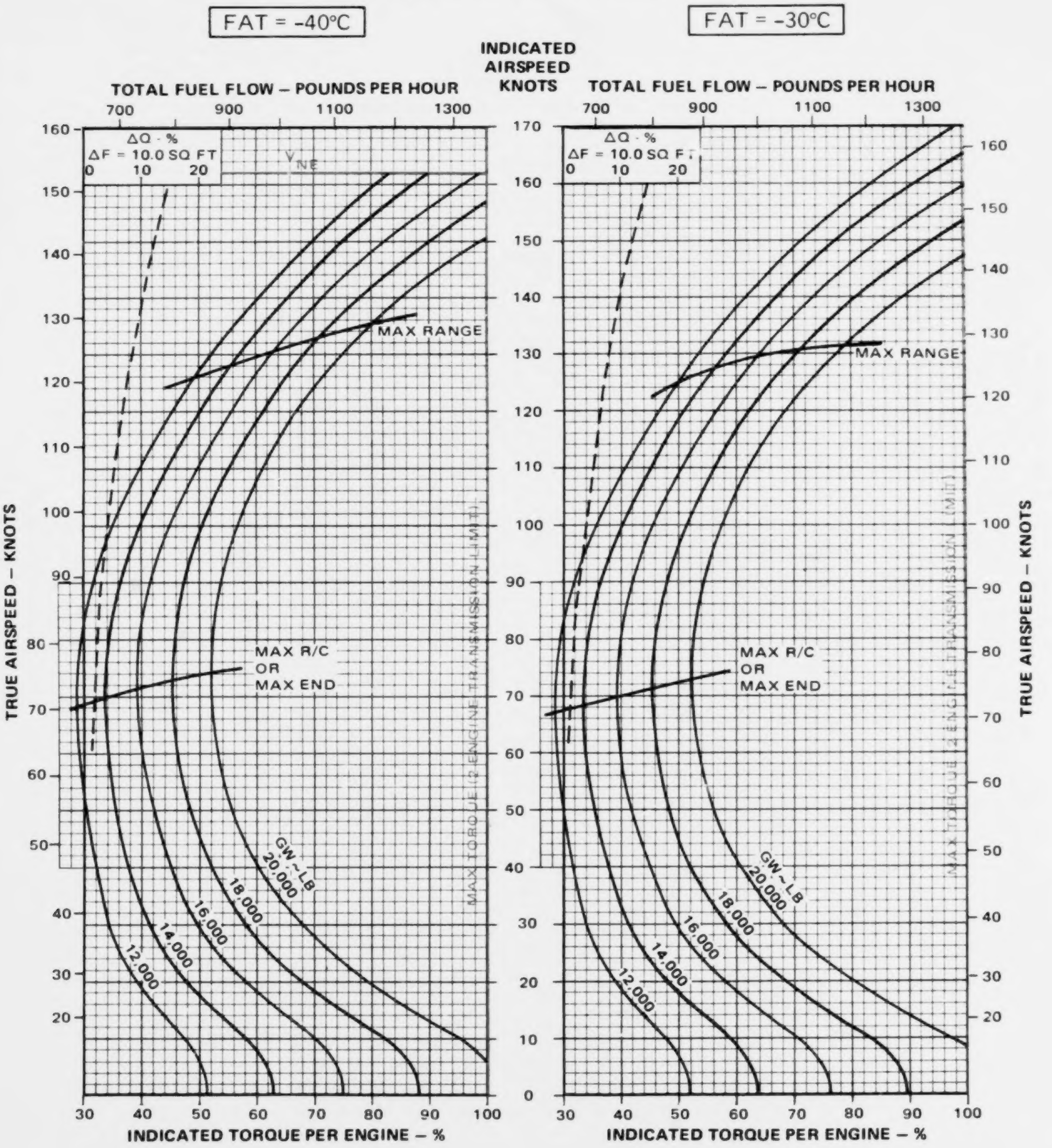
Figure 7-15. Cruise Chart, 2,000 Feet, -50°C

R

CRUISE

PRESSURE ALTITUDE - 2000 FEET

100% RPM, 8 HELLFIRE CONFIGURATION, JP-4 FUEL



R

MM01-145

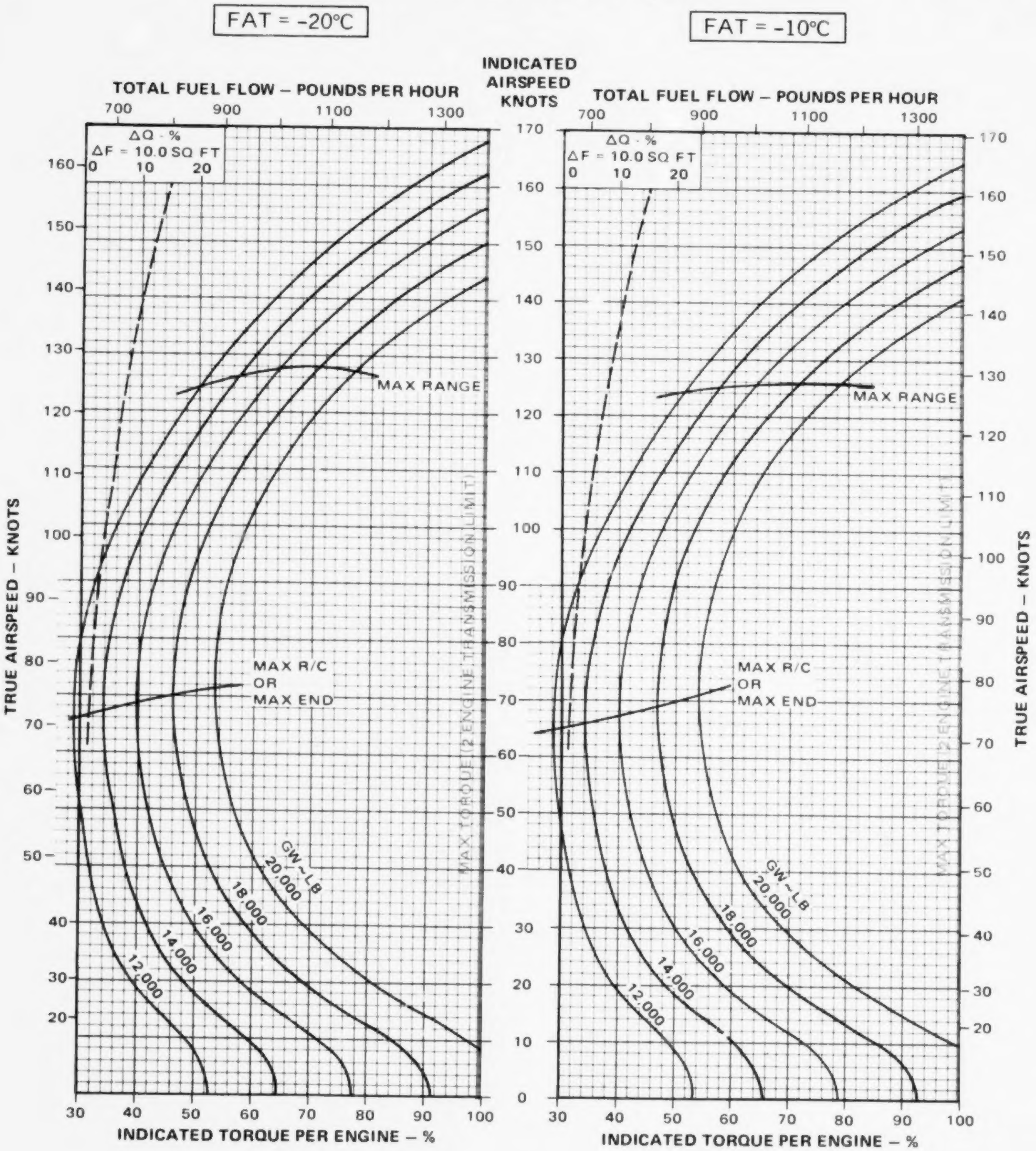
Figure 7-16. Cruise Chart, 2,000 Feet, -40° and -30°C

R

CRUISE

PRESSURE ALTITUDE - 2000 FEET

100% RPM, 8 HELLFIRE CONFIGURATION, JP-4 FUEL



R

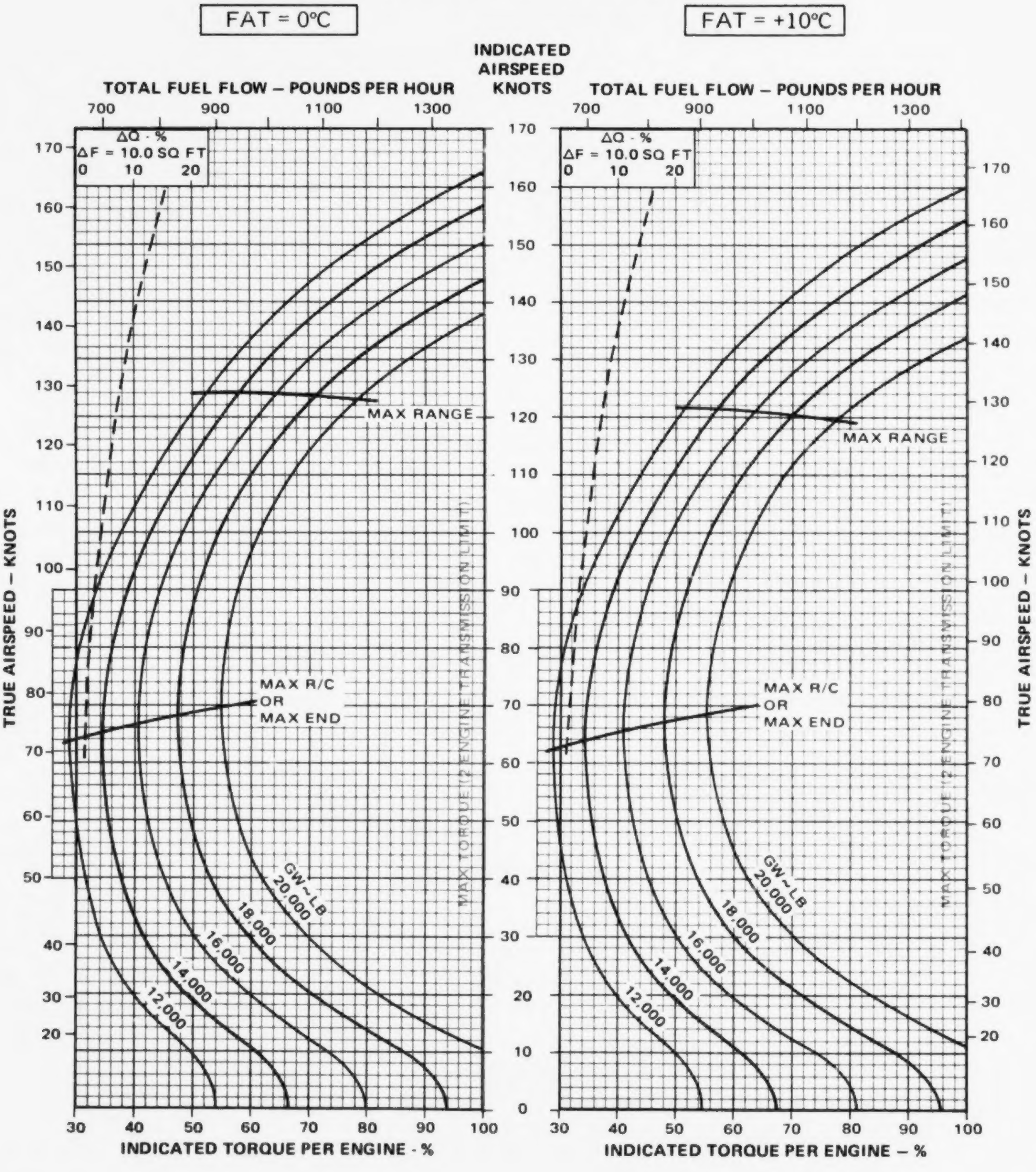
Figure 7-17. Cruise Chart, 2,000 Feet, -20° and -10°C

R

CRUISE

PRESSURE ALTITUDE - 2000 FEET

100% RPM, 8 HELLFIRE CONFIGURATION, JP-4 FUEL



R

MM01-147

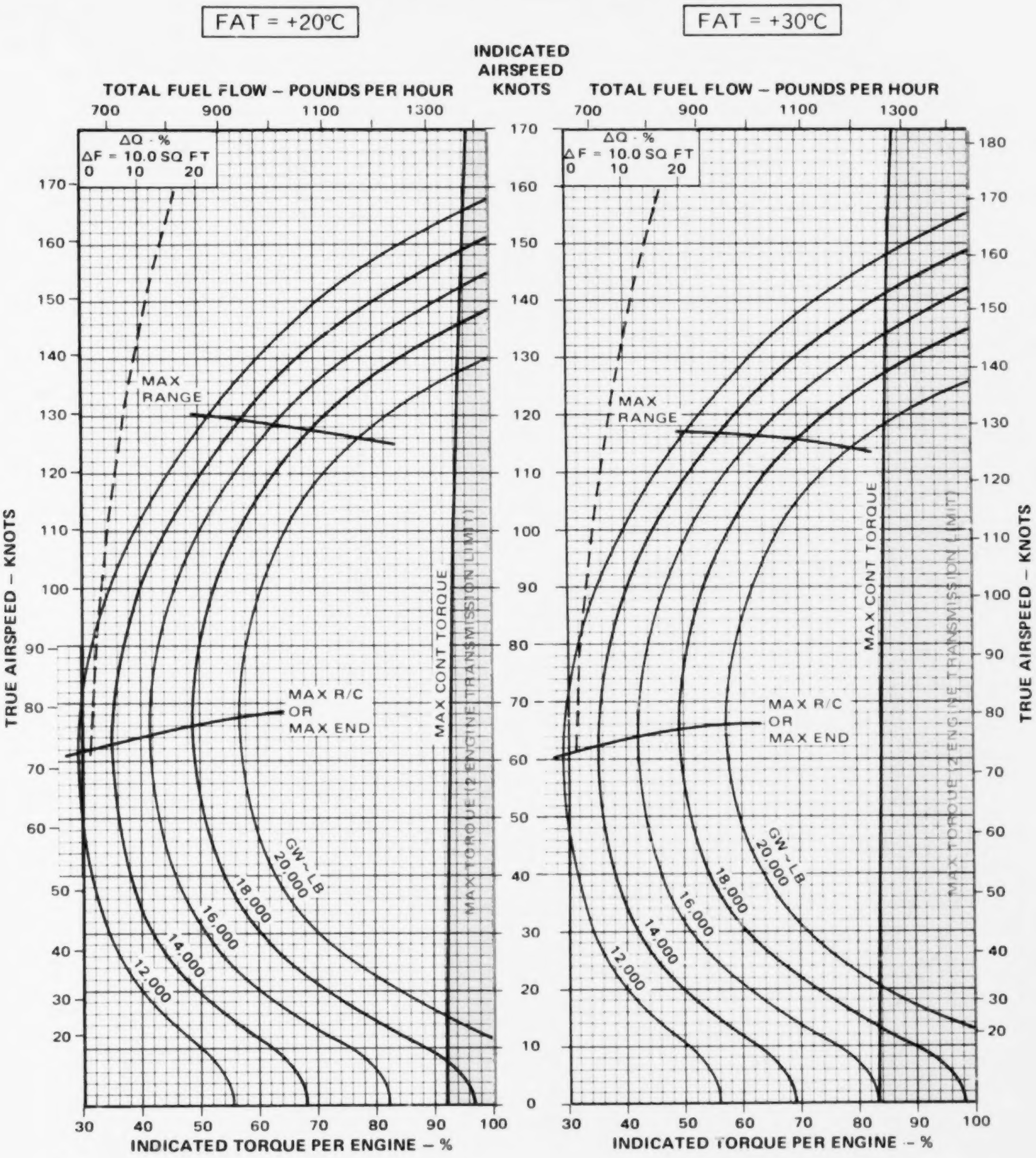
Figure 7-18. Cruise Chart, 2,000 Feet, 0° and + 10°C

■ ☐
R Y

CRUISE

PRESSURE ALTITUDE - 2000 FEET

100% RPM, 8 HELLFIRE CONFIGURATION, JP-4 FUEL

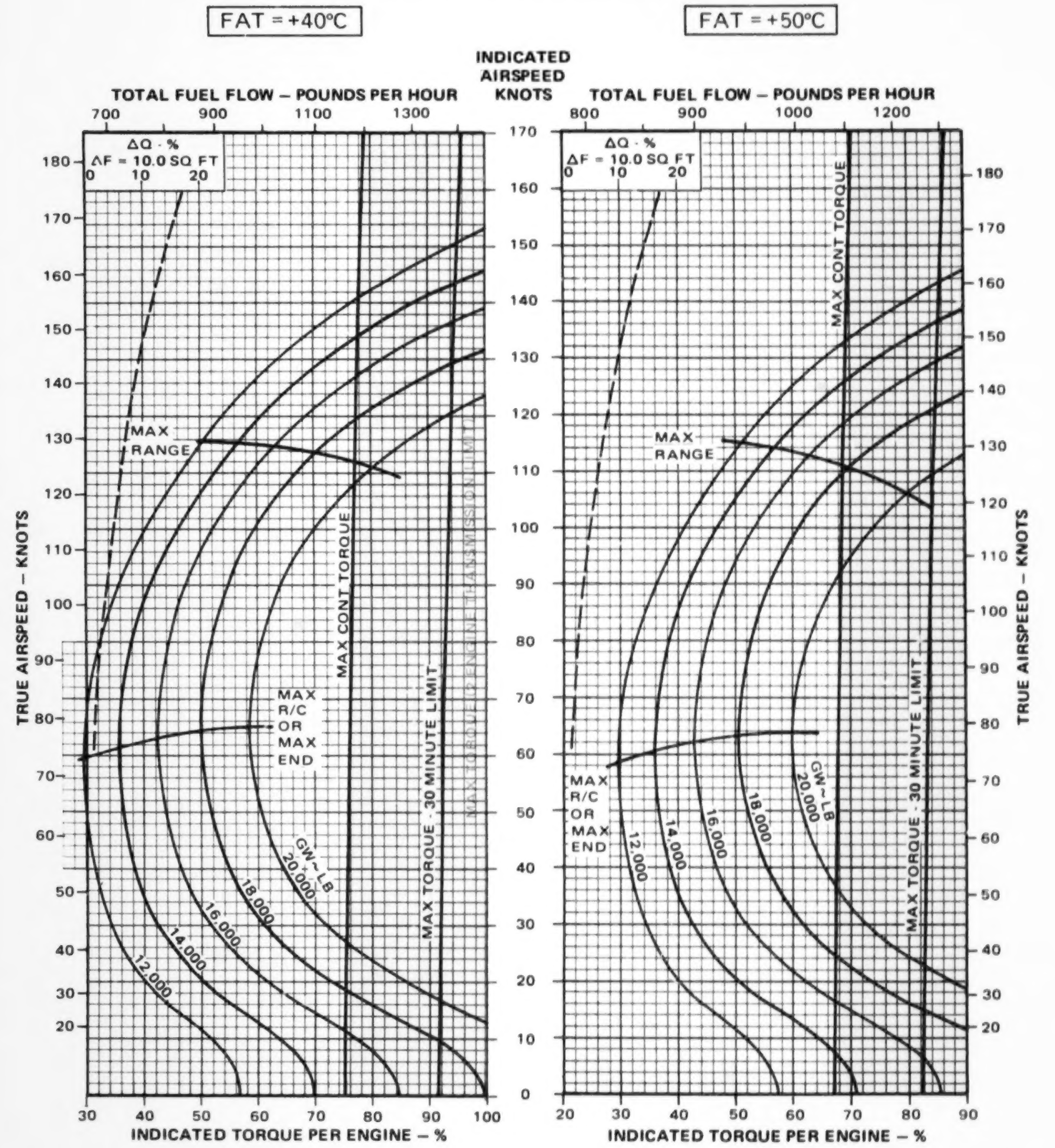


■ ☐
R Y
MM01-148

Figure 7-19. Cruise Chart, 2,000 Feet, + 20° and + 30°C

▨ ☐
R Y

CRUISE
PRESSURE ALTITUDE - 2000 FEET
100% RPM, 8 HELLFIRE CONFIGURATION, JP-4 FUEL



▨ ☐
R Y
MM01-149

Figure 7-20. Cruise Chart, 2,000 Feet, + 40° and + 50°C

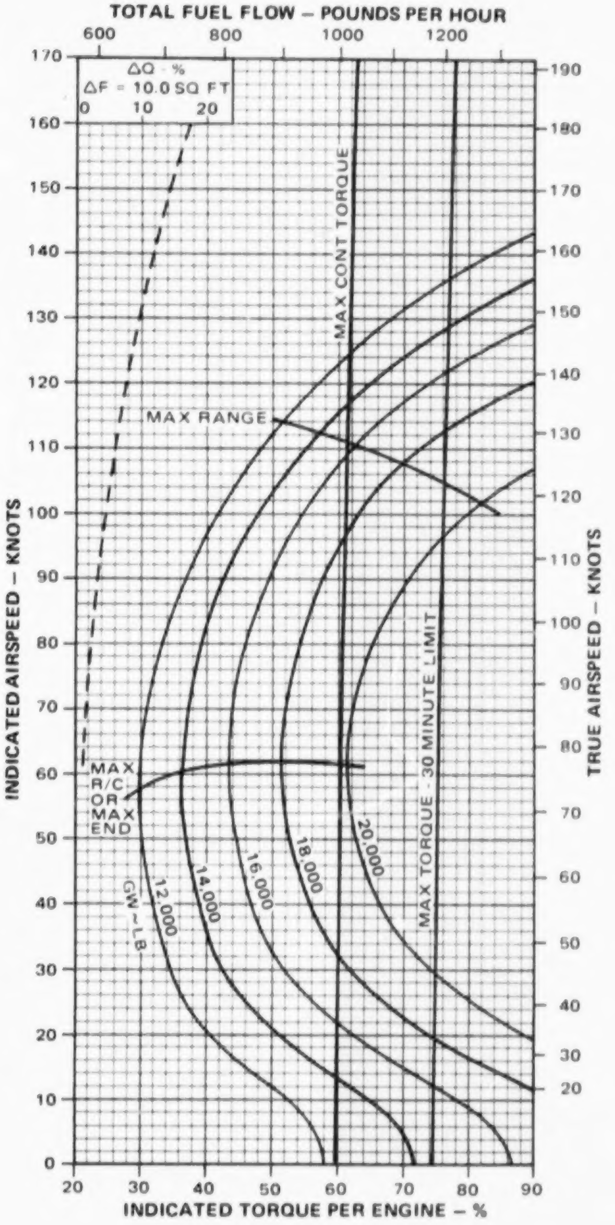
☐
Y

CRUISE

PRESSURE ALTITUDE – 2000 FEET

100% RPM, 8 HELLFIRE CONFIGURATION, JP-4 FUEL

FAT = +60°C



☐
Y

MM01-201

Figure 7-21. Cruise Chart, 2,000 Feet, +60°C

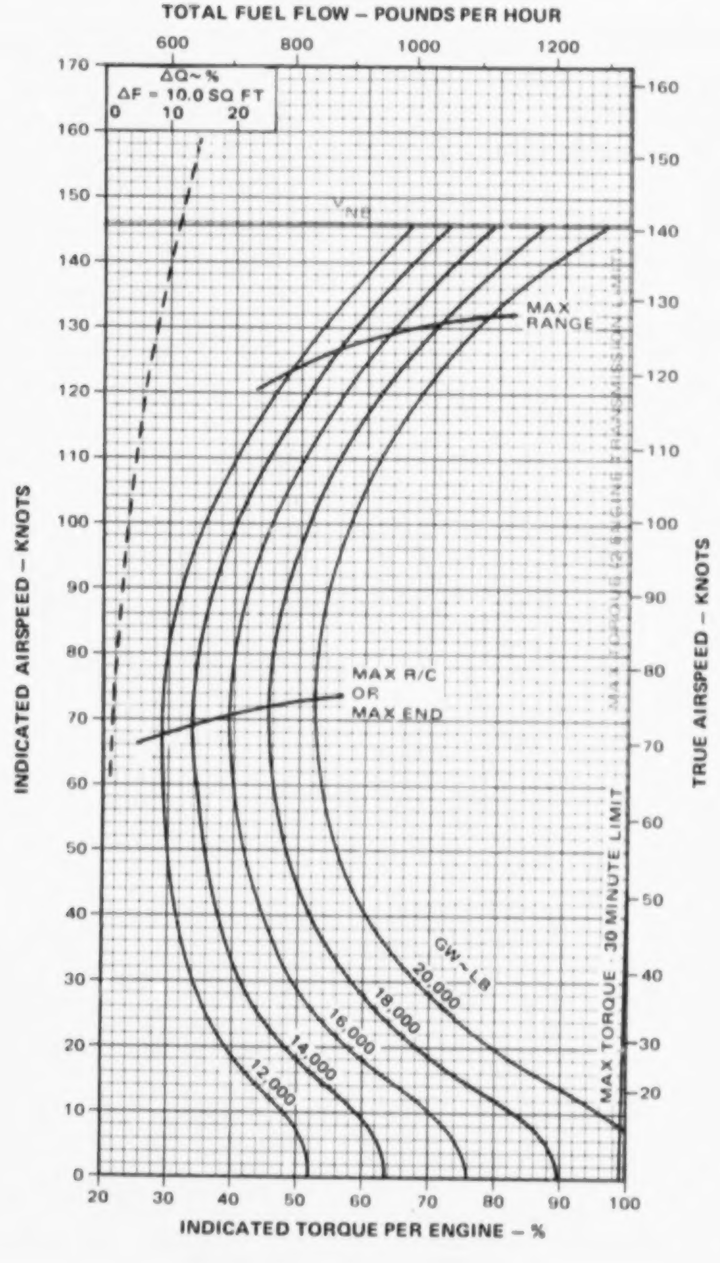
R

CRUISE

PRESSURE ALTITUDE - 4000 FEET

100% RPM, 8 HELLFIRE CONFIGURATION, JP-4 FUEL

FAT = -50°C



R

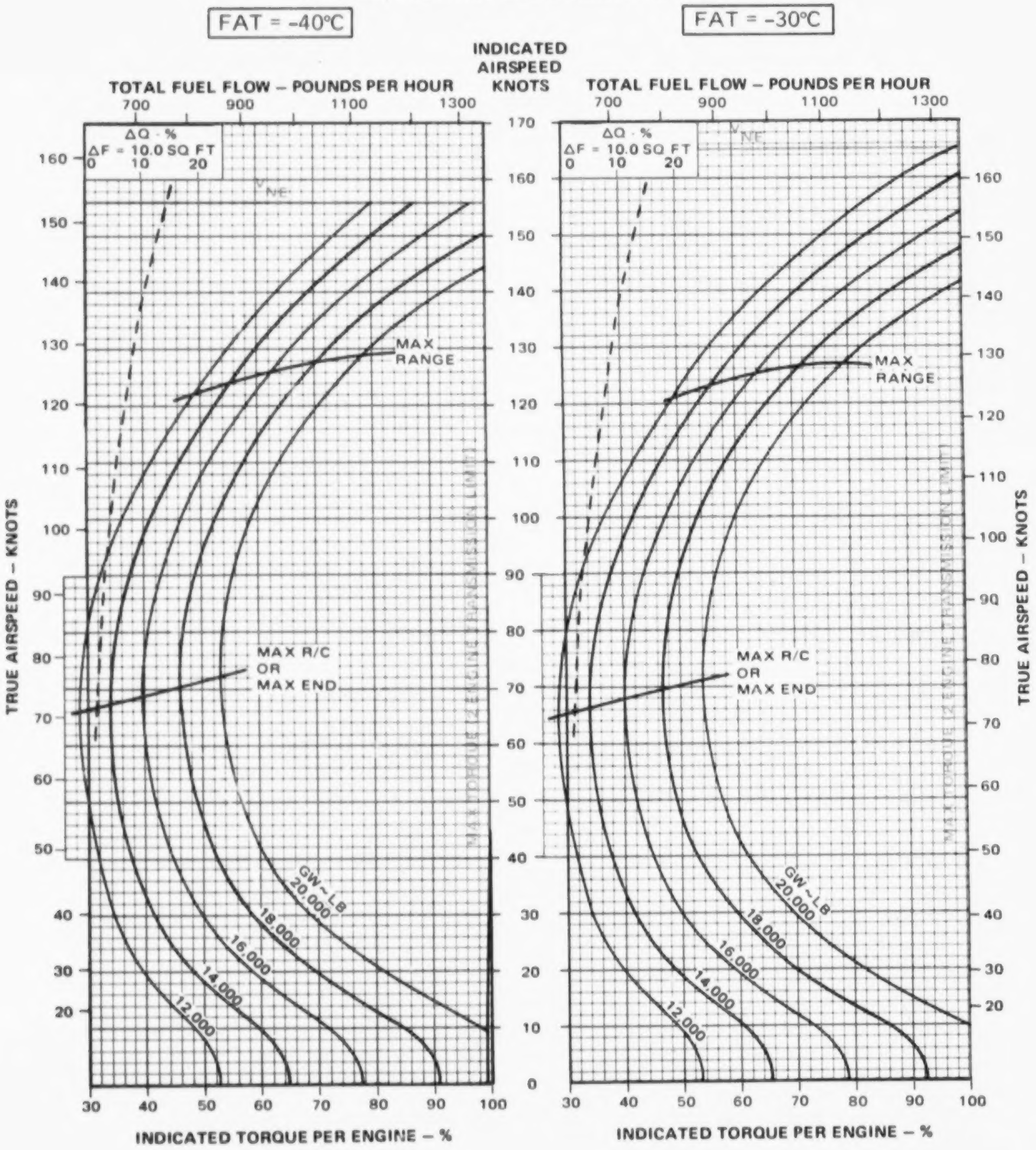
MM01-194

Figure 7-22. Cruise Chart, 4,000 Feet, -50°C

CRUISE

PRESSURE ALTITUDE - 4000 FEET

100% RPM, 8 HELLFIRE CONFIGURATION, JP-4 FUEL



MM01-0568

Figure 7-23. Cruise Chart, 4,000 Feet, -40° and -30°C

CRUISE

PRESSURE ALTITUDE – 4000 FEET

100% RPM, 8 HELLFIRE CONFIGURATION, JP-4 FUEL

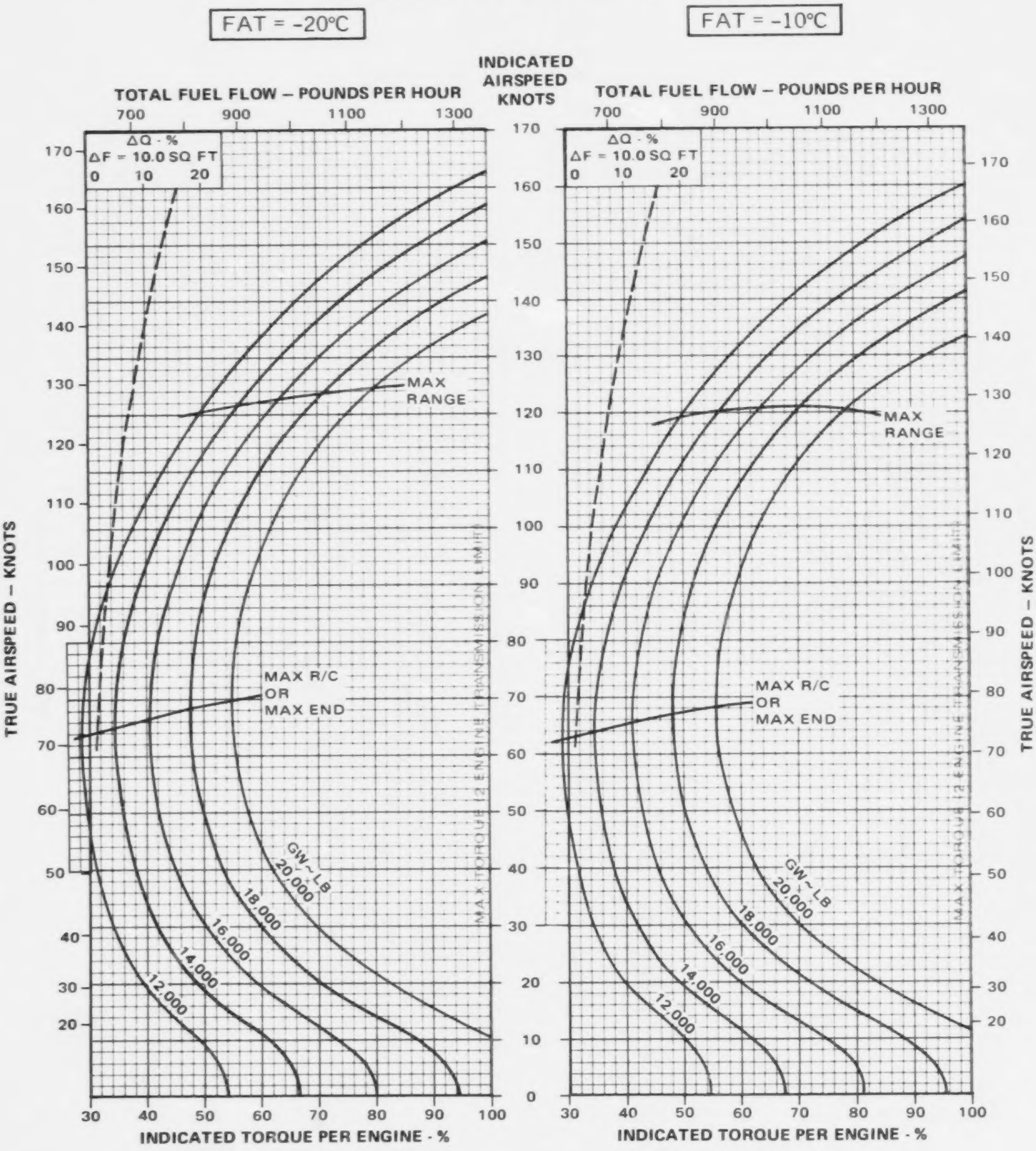


Figure 7-24. Cruise Chart, 4,000 Feet, -20° and -10°C

▨ ☐
R Y

CRUISE

PRESSURE ALTITUDE – 4000 FEET

100% RPM, 8 HELLFIRE CONFIGURATION, JP-4 FUEL

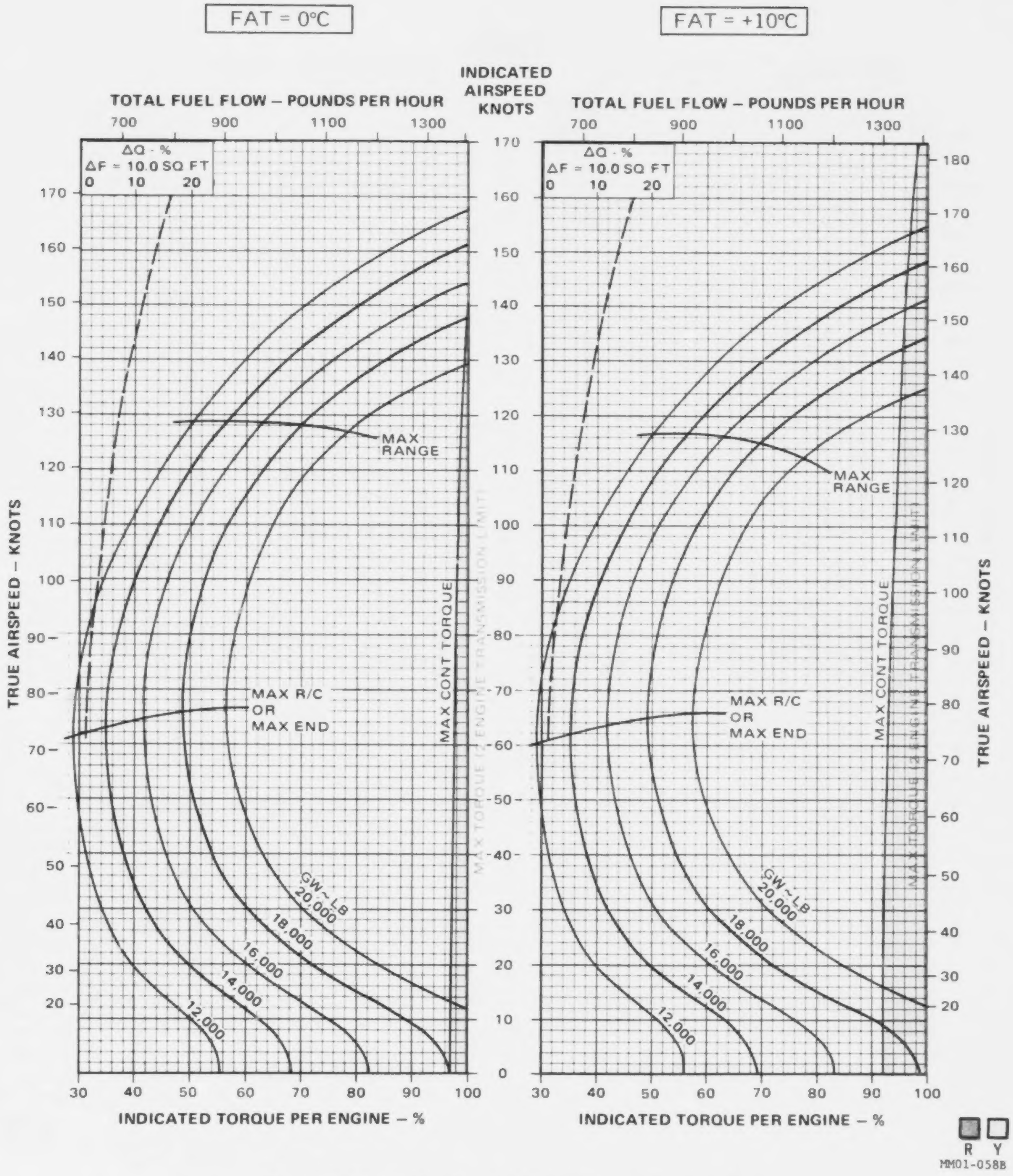


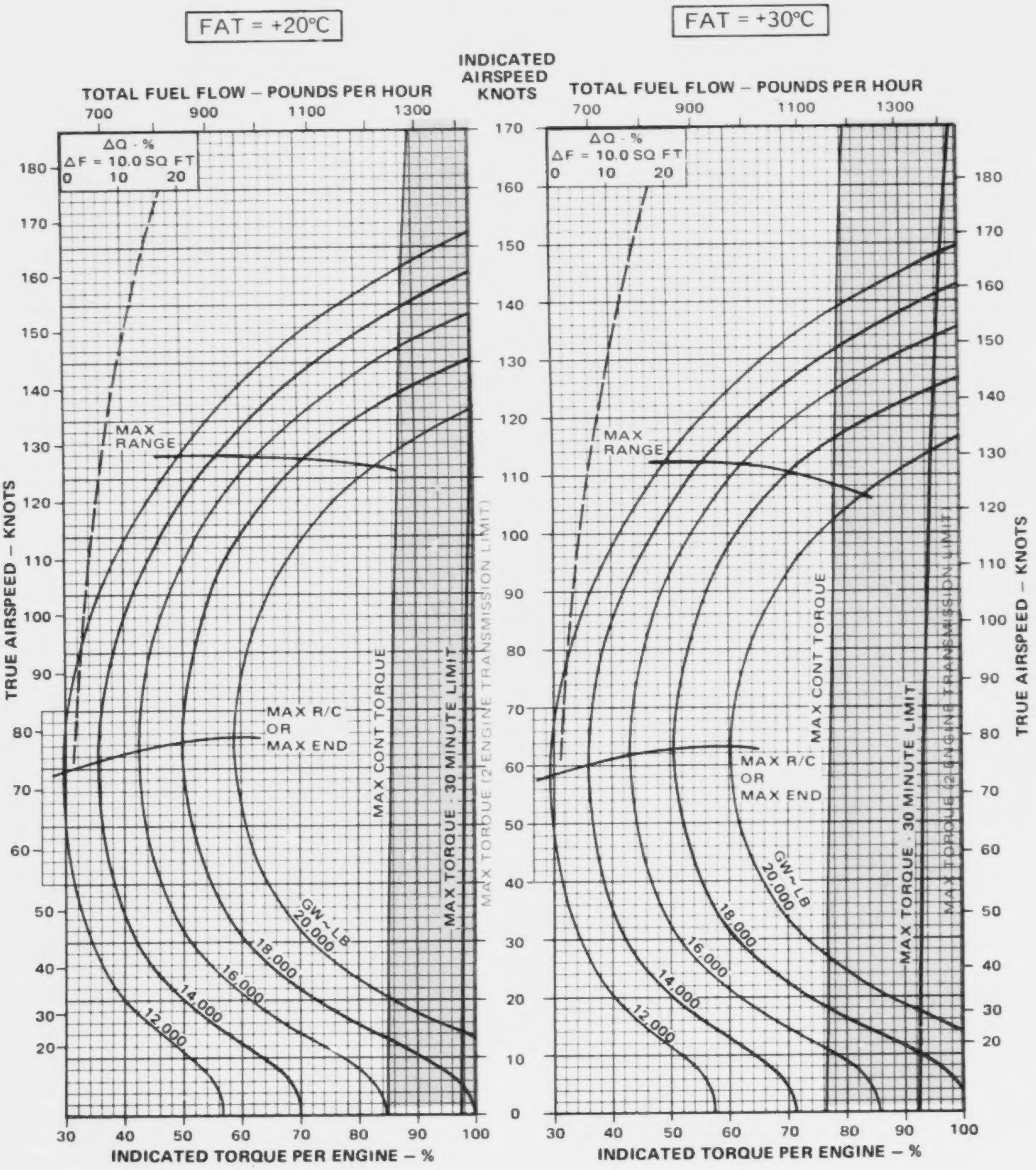
Figure 7-25. Cruise Chart, 4,000 Feet, 0° and + 10°C

🟥 ☐
R Y

CRUISE

PRESSURE ALTITUDE – 4000 FEET

100% RPM, 8 HELLFIRE CONFIGURATION, JP-4 FUEL



🟥 ☐
R Y

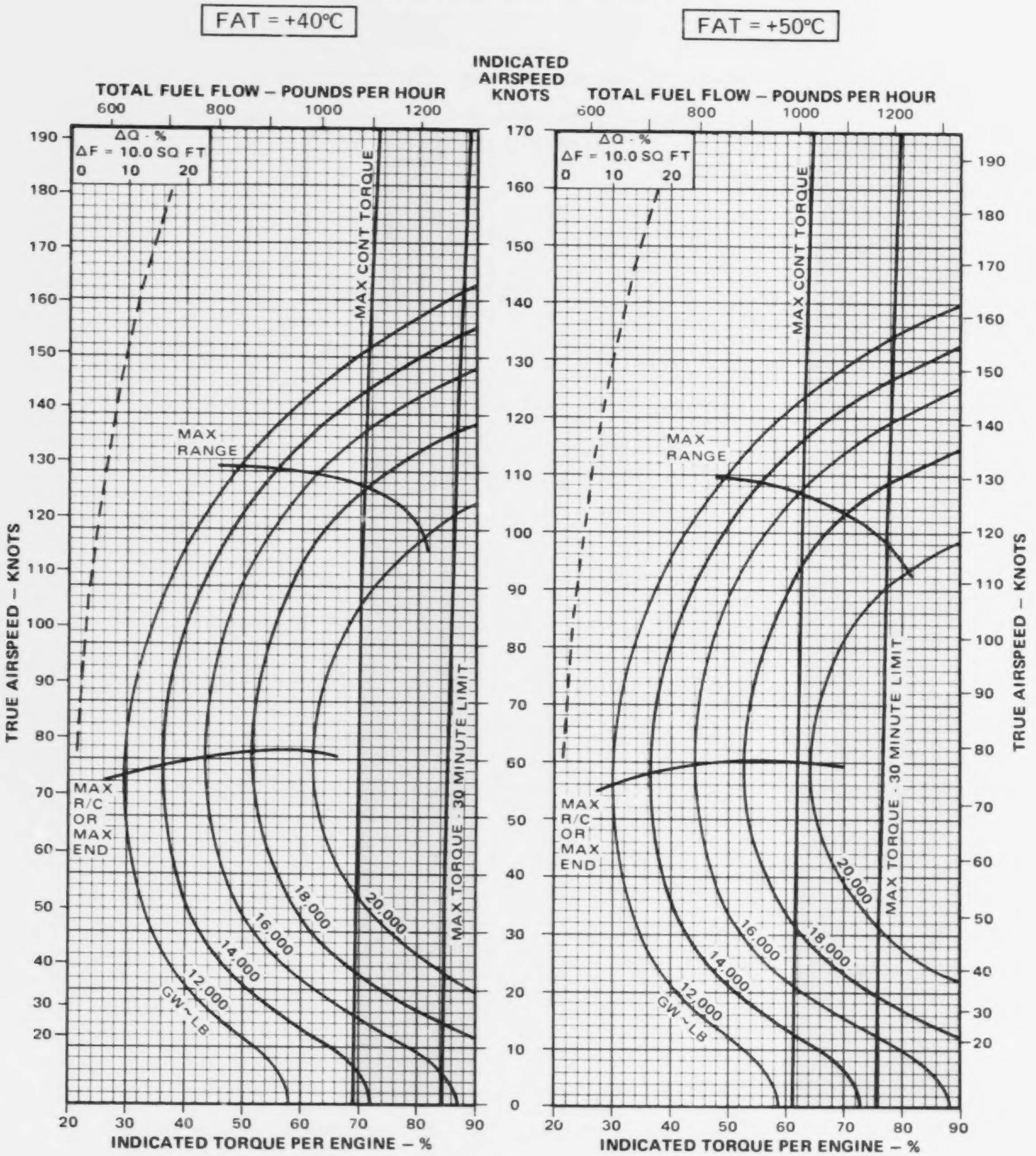
Figure 7-26. Cruise Chart, 4,000 Feet, + 20° and + 30°C

MM01-059B

CRUISE

PRESSURE ALTITUDE - 4000 FEET

100% RPM, 8 HELLFIRE CONFIGURATION, JP-4 FUEL



MM01-060B

Figure 7-27. Cruise Chart, 4,000 Feet, + 40° and + 50°C

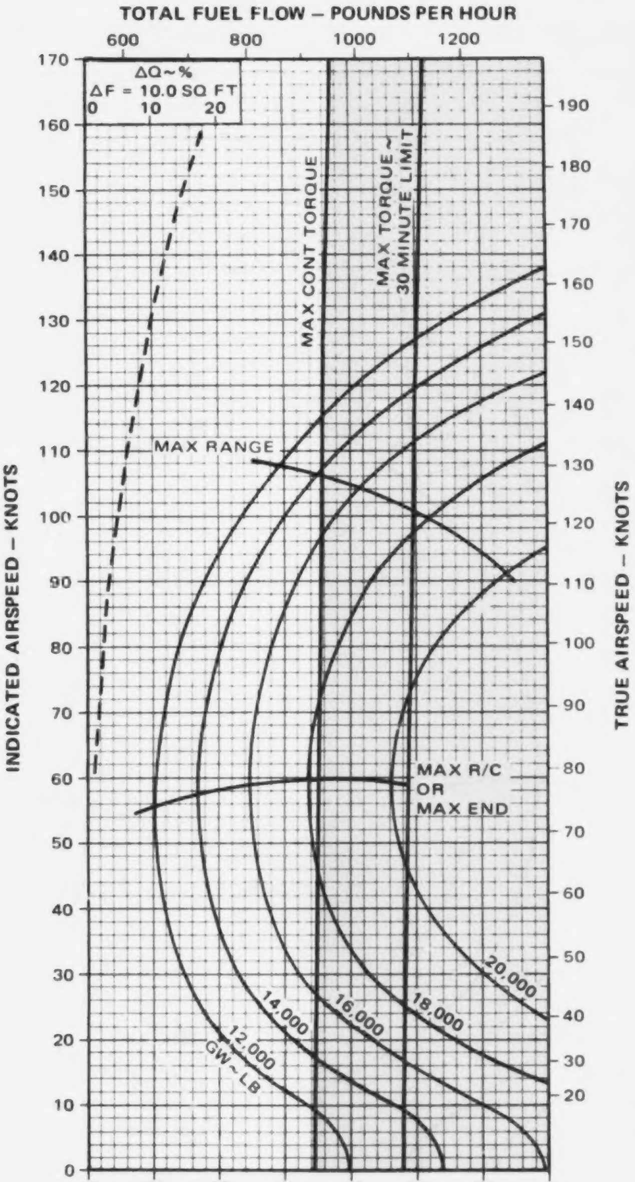
☐
Y

CRUISE

PRESSURE ALTITUDE - 4000 FEET

100% RPM, 8 HELLFIRE CONFIGURATION, JP-4 FUEL

FAT = +60°C



☐
Y
MM01-200

Figure 7-28. Cruise Chart, 4,000 Feet, + 60°C

CRUISE

PRESSURE ALTITUDE - 6000 FEET

100% RPM, 8 HELLFIRE CONFIGURATION, JP-4 FUEL

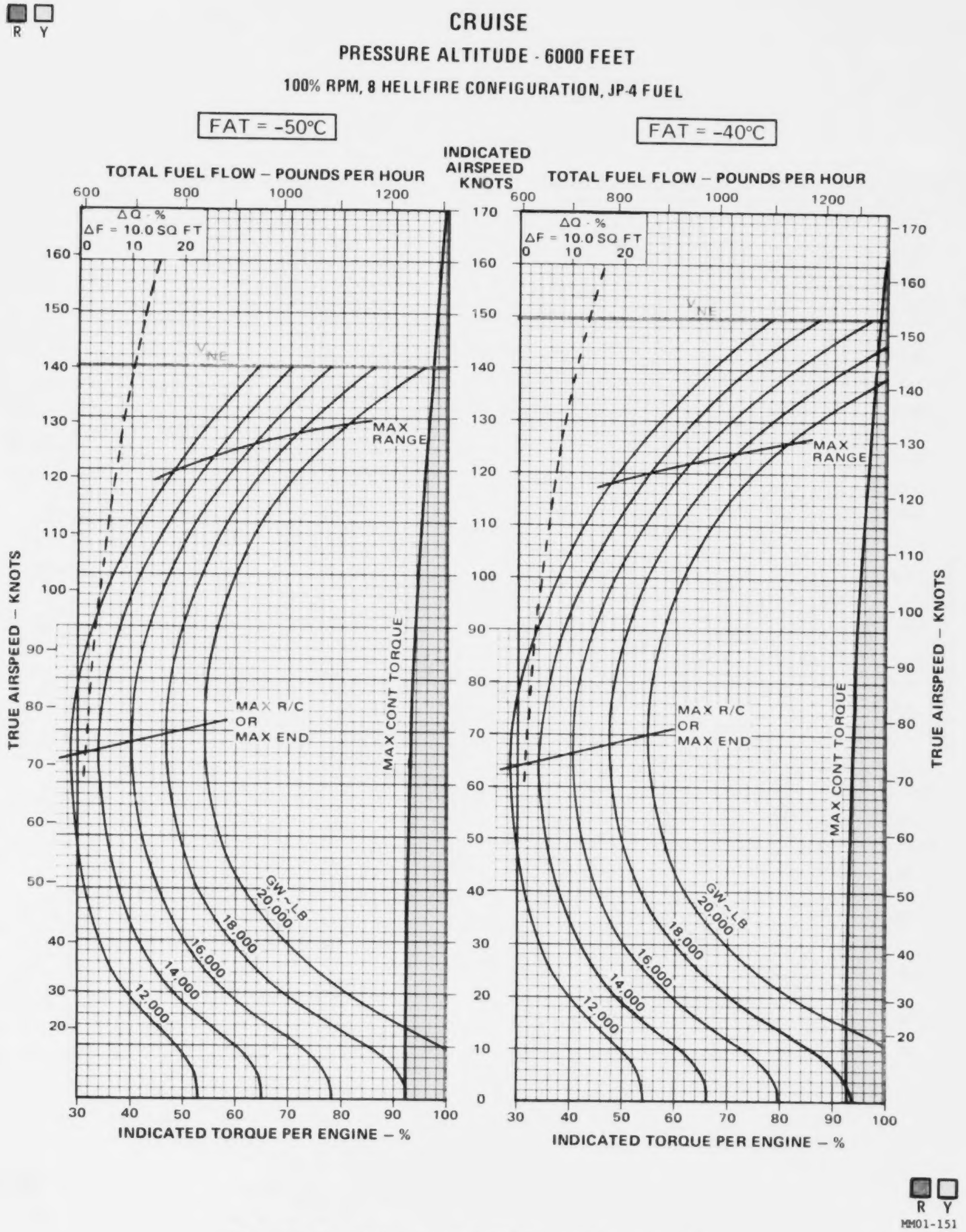


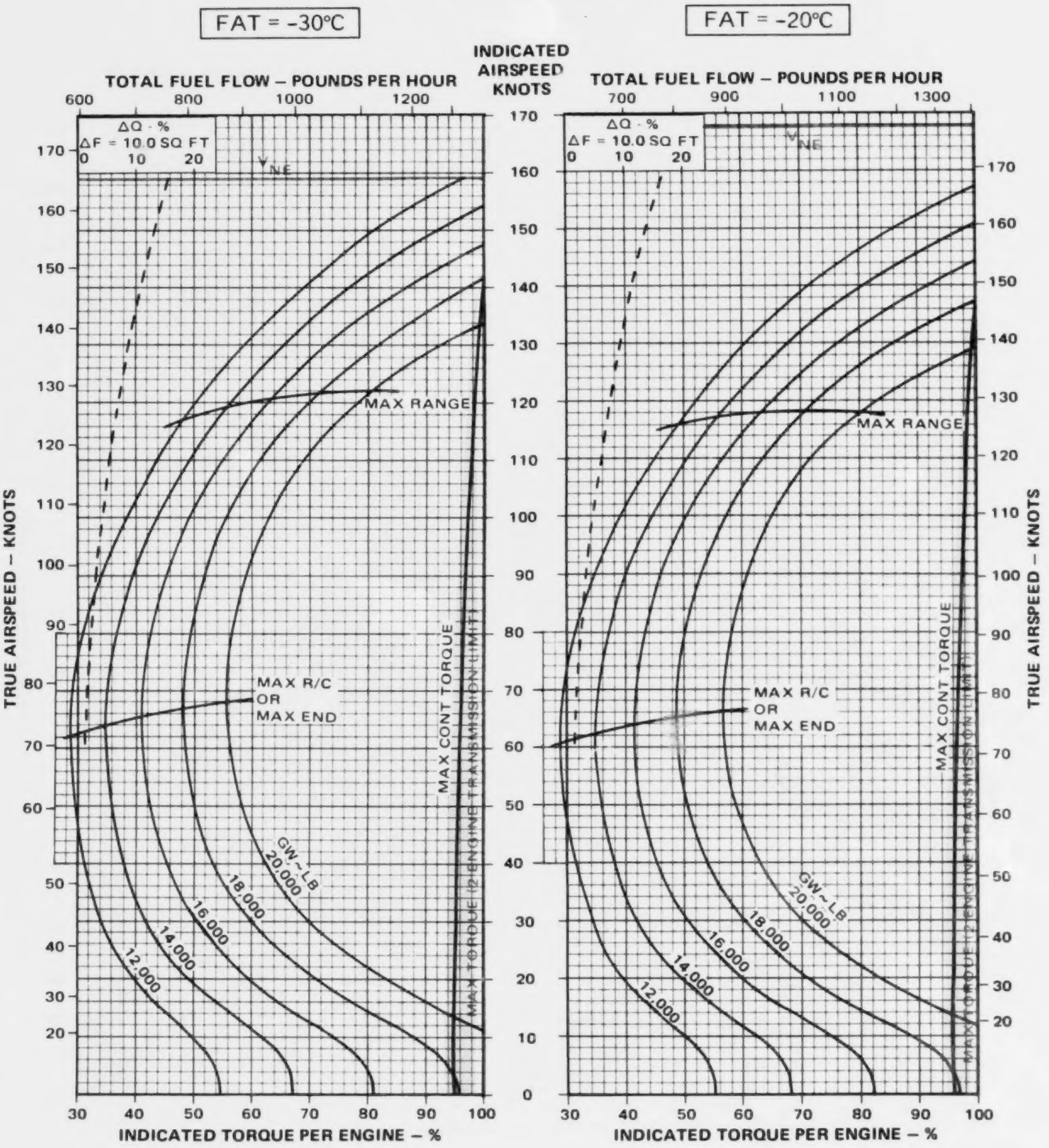
Figure 7-29. Cruise Chart, 6,000 Feet, -50° and -40°C

■ □
R Y

CRUISE

PRESSURE ALTITUDE - 6000 FEET

100% RPM, 8 HELLFIRE CONFIGURATION, JP-4 FUEL



■ □
R Y
MM01-151

Figure 7-30. Cruise Chart, 6,000 Feet, -30° and -20°C

CRUISE

PRESSURE ALTITUDE - 6000 FEET

100% RPM, 8 HELLFIRE CONFIGURATION, JP-4 FUEL

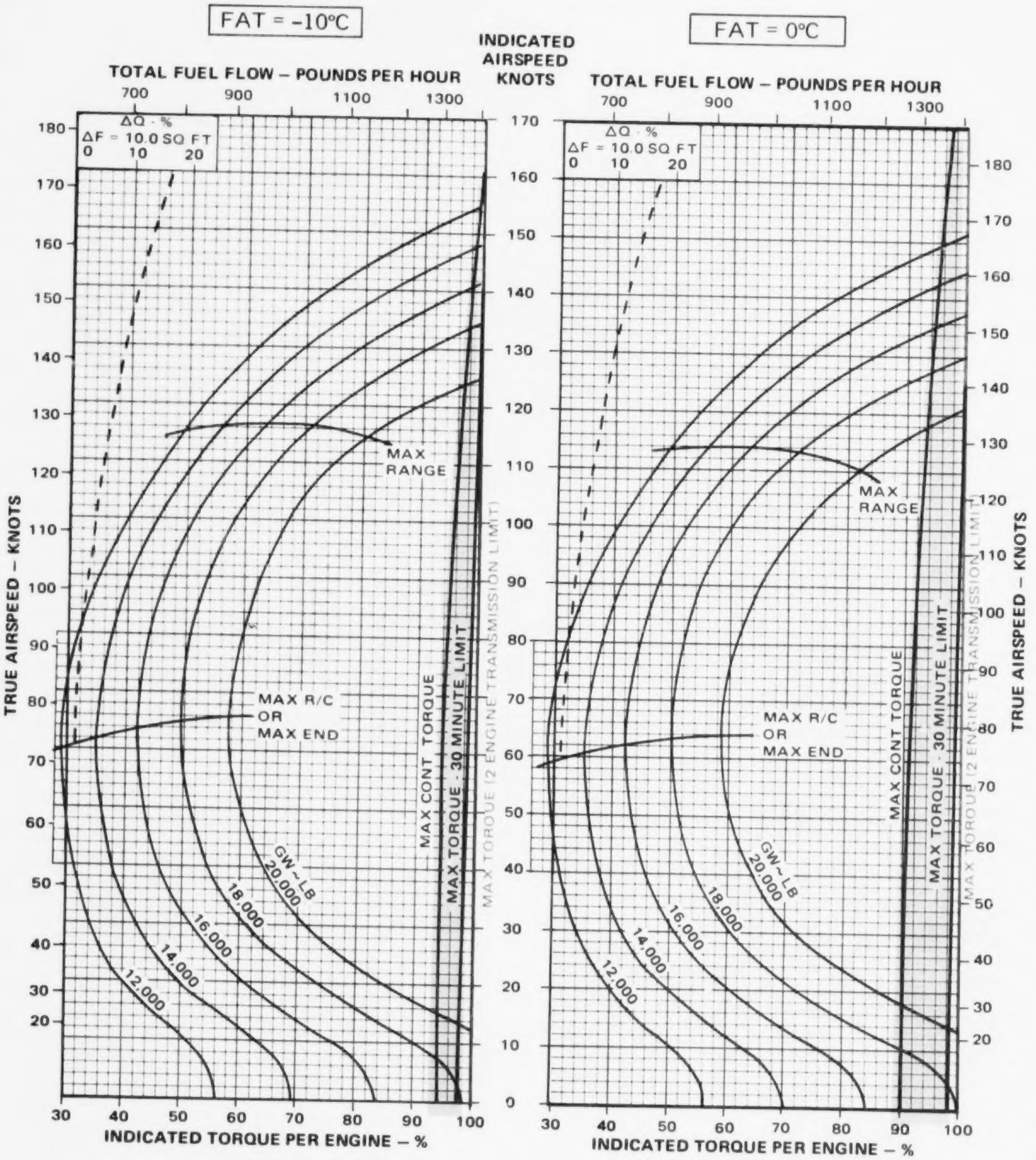


Figure 7-31. Cruise Chart, 6,000 Feet, -10° and 0°C

■ ☐
R Y

CRUISE

PRESSURE ALTITUDE - 6000 FEET

100% RPM, 8 HELLFIRE CONFIGURATION, JP-4 FUEL

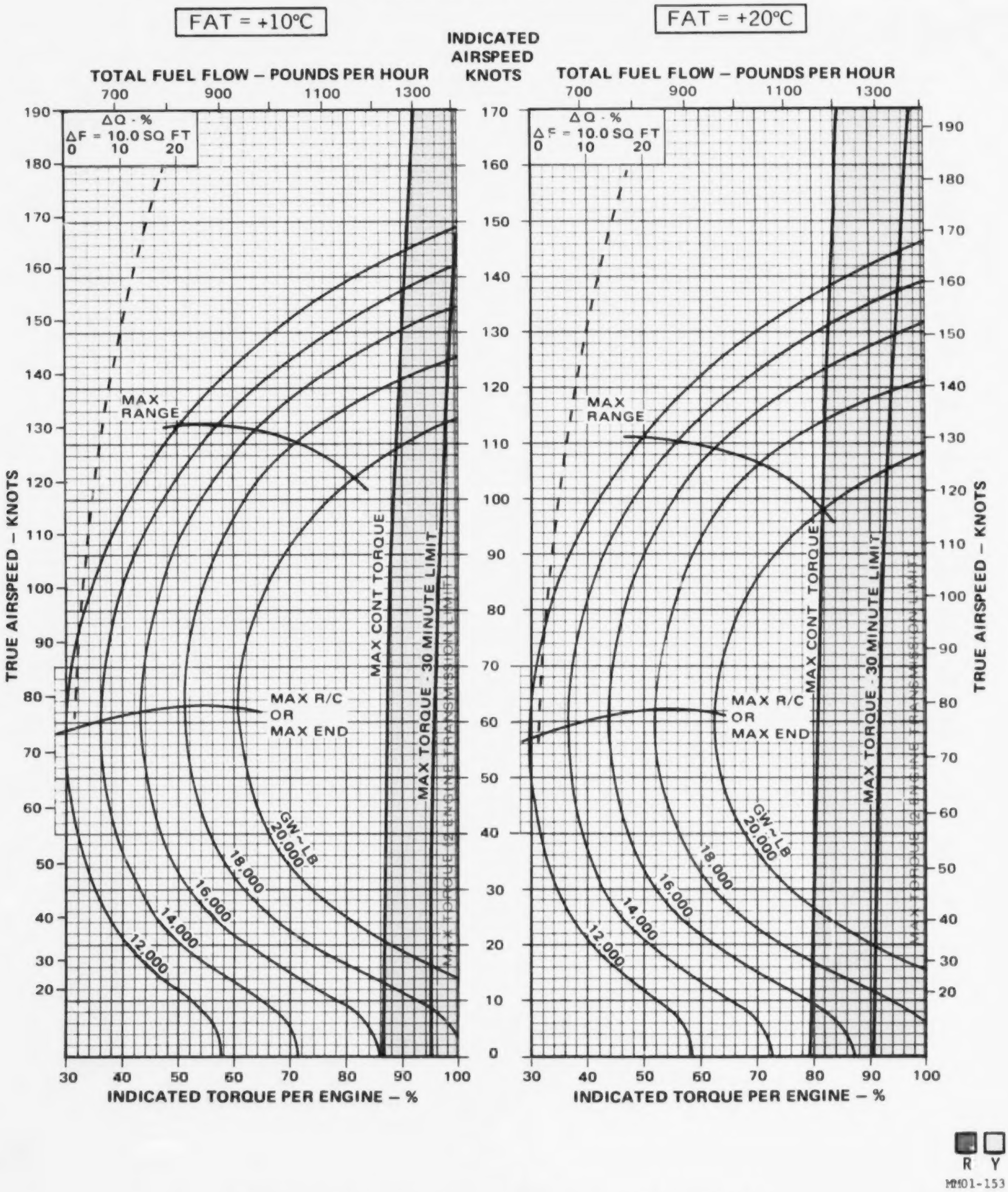


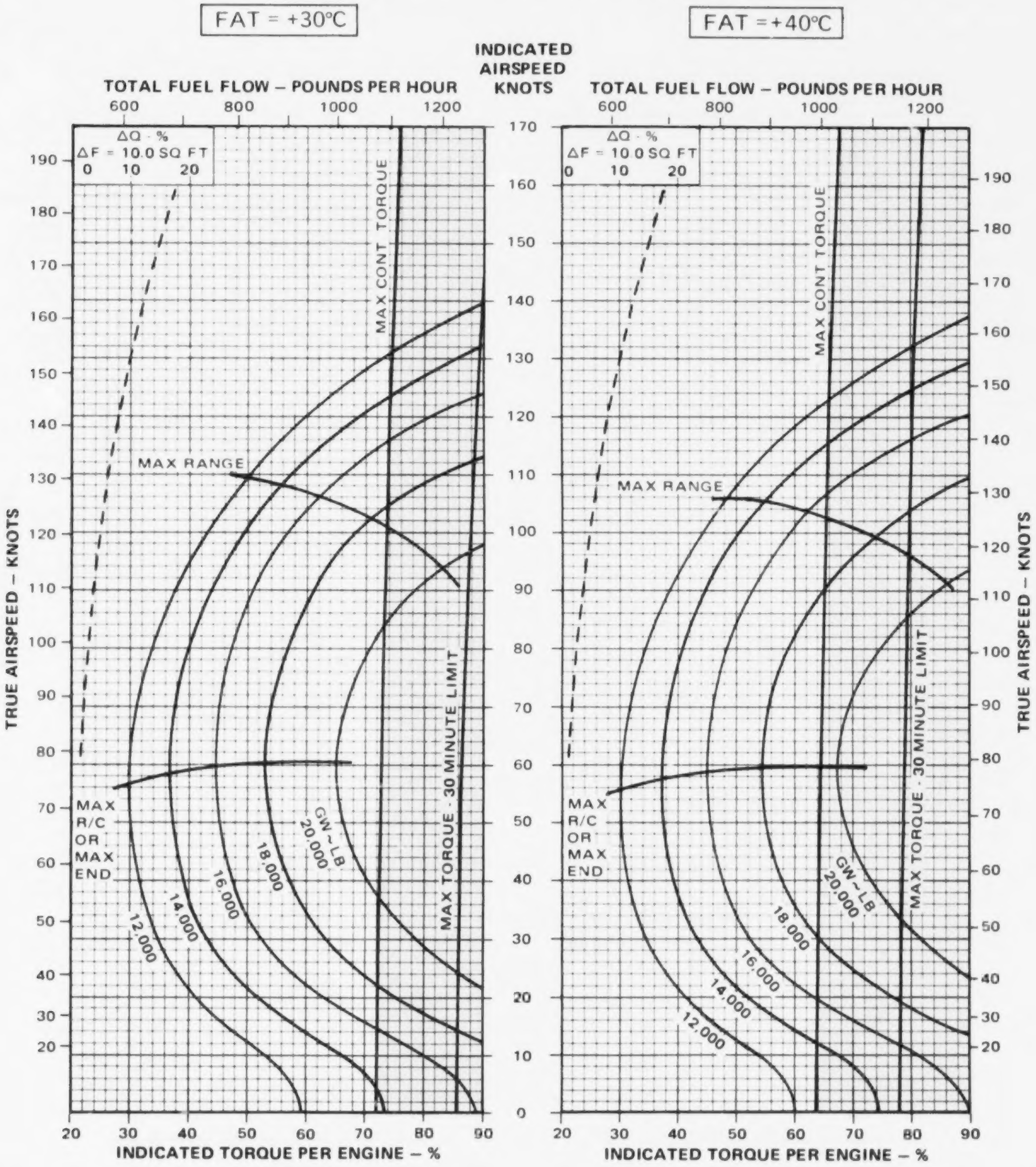
Figure 7-32. Cruise Chart, 6,000 Feet, + 10° and + 20°C

☐
Y

CRUISE

PRESSURE ALTITUDE - 6000 FEET

100% RPM, 8 HELLFIRE CONFIGURATION, JP-4 FUEL



☐
Y

MM01-154

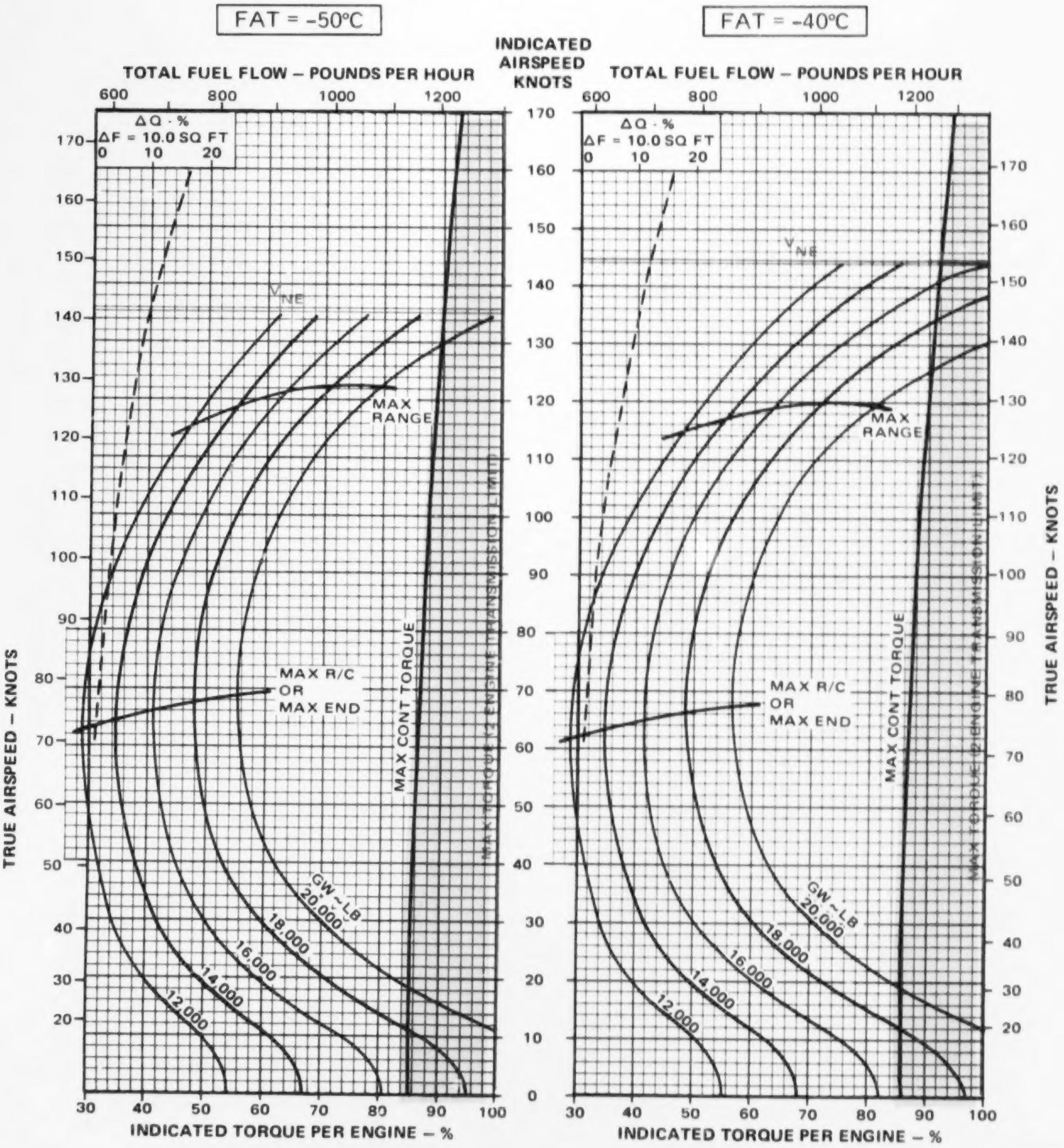
Figure 7-33. Cruise Chart, 6,000 Feet, + 30° and + 40°C

■ □
R Y

CRUISE

PRESSURE ALTITUDE - 8000 FEET

100% RPM, 8 HELLFIRE CONFIGURATION, JP-4 FUEL



□ ■
Y R
MM01-155A

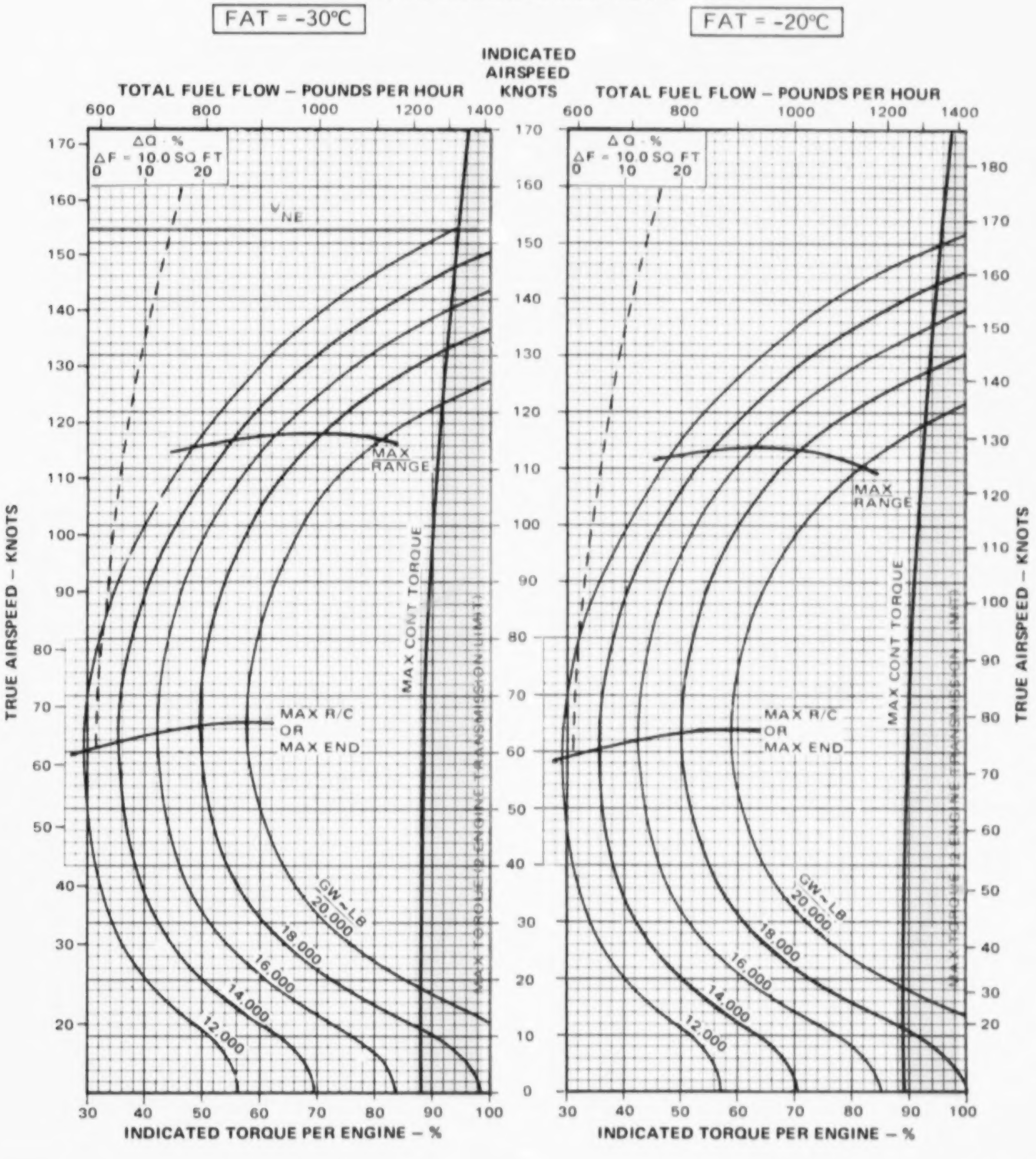
Figure 7-34. Cruise Chart, 8,000 Feet, -50° and -40°C

■ □
R Y

CRUISE

PRESSURE ALTITUDE - 8000 FEET

100% RPM, 8 HELLFIRE CONFIGURATION, JP-4 FUEL



■ □
R Y
MM01-156

Figure 7-35. Cruise Chart, 8,000 Feet, -30° and -20°C

▨ ☐
R Y

CRUISE

PRESSURE ALTITUDE - 8000 FEET

100% RPM, 8 HELLFIRE CONFIGURATION, JP-4 FUEL

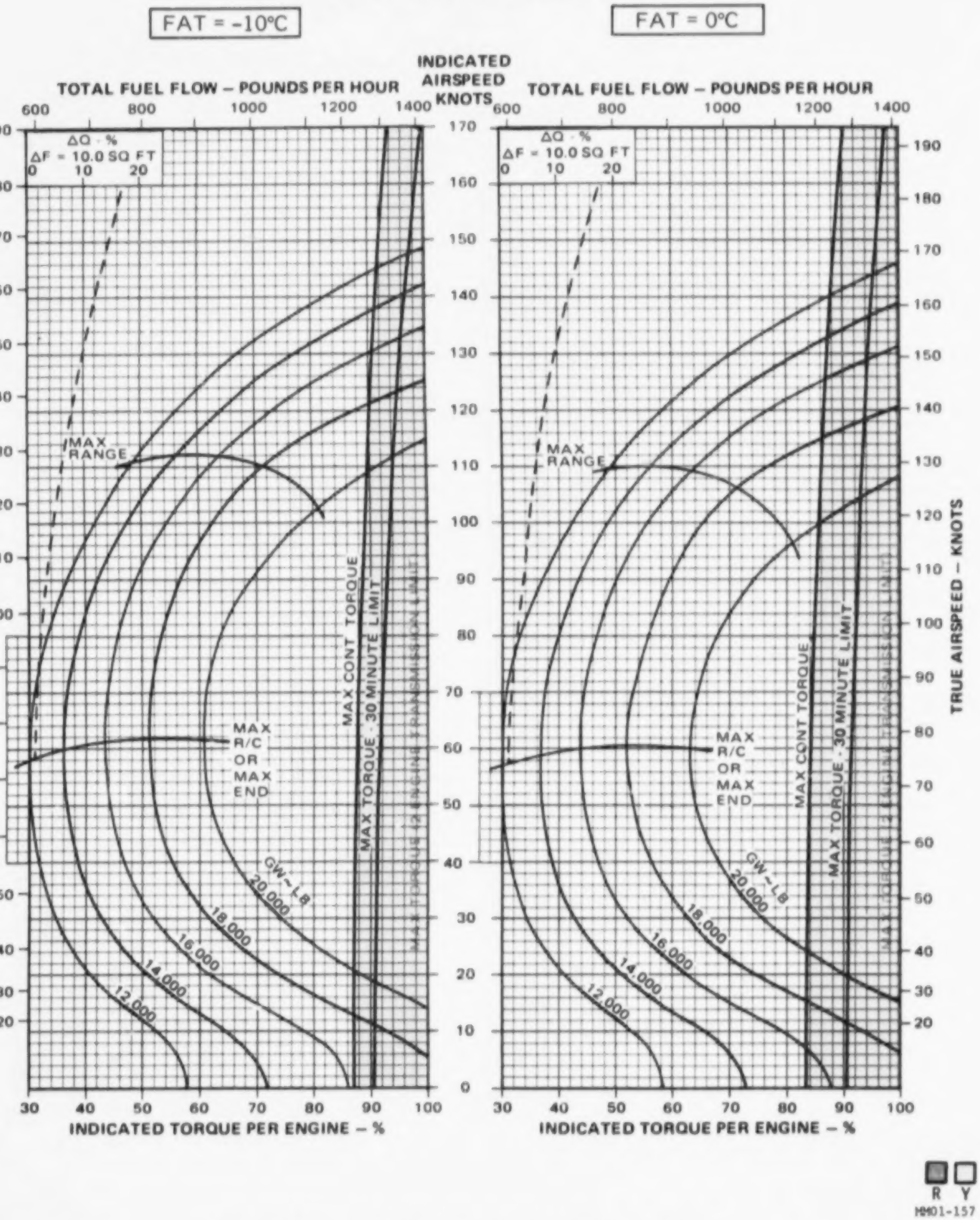


Figure 7-36. Cruise Chart, 8,000 Feet, -10° and 0°C

CRUISE

PRESSURE ALTITUDE - 8000 FEET

100% RPM, 8 HELLFIRE CONFIGURATION, JP-4 FUEL

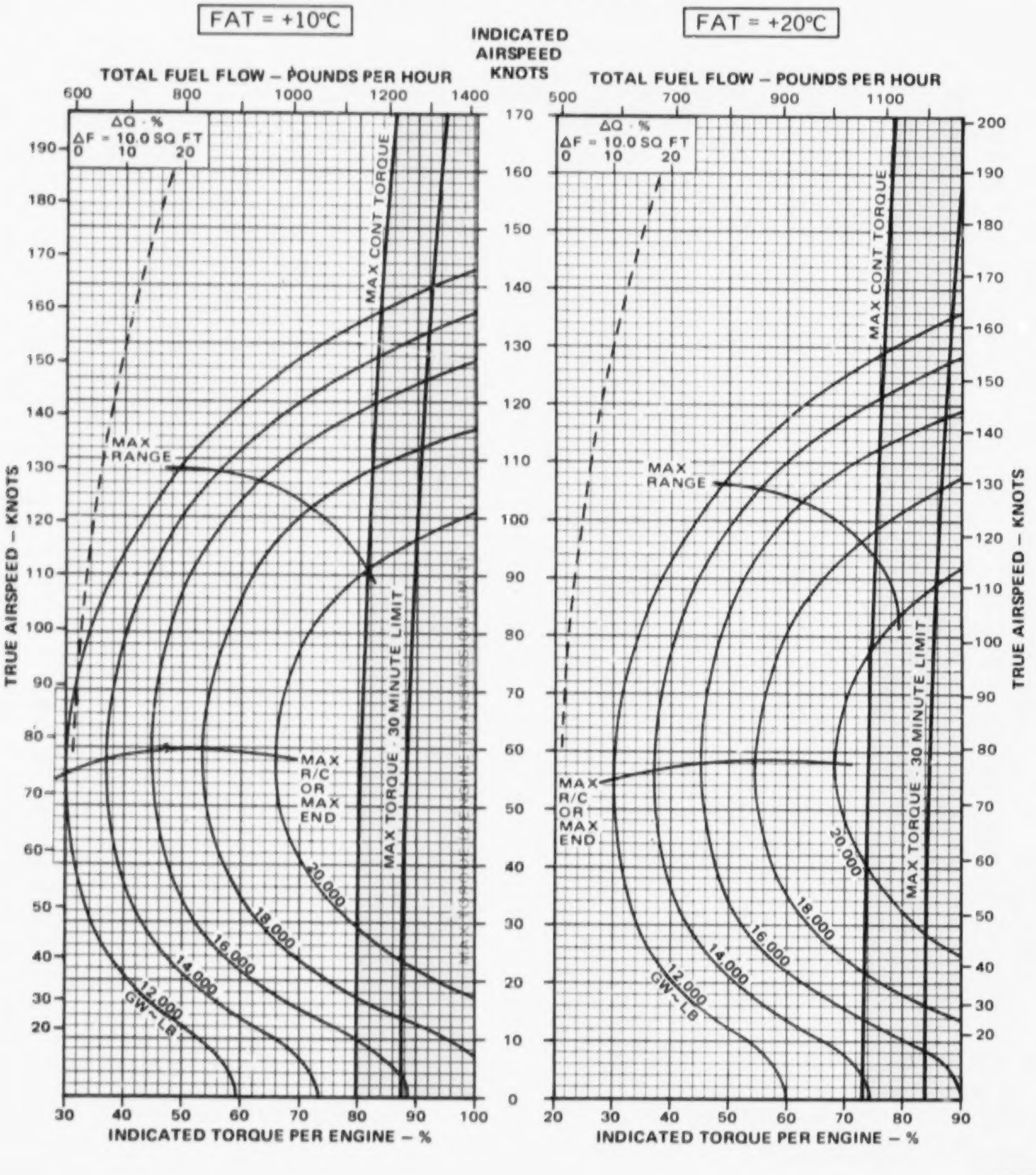


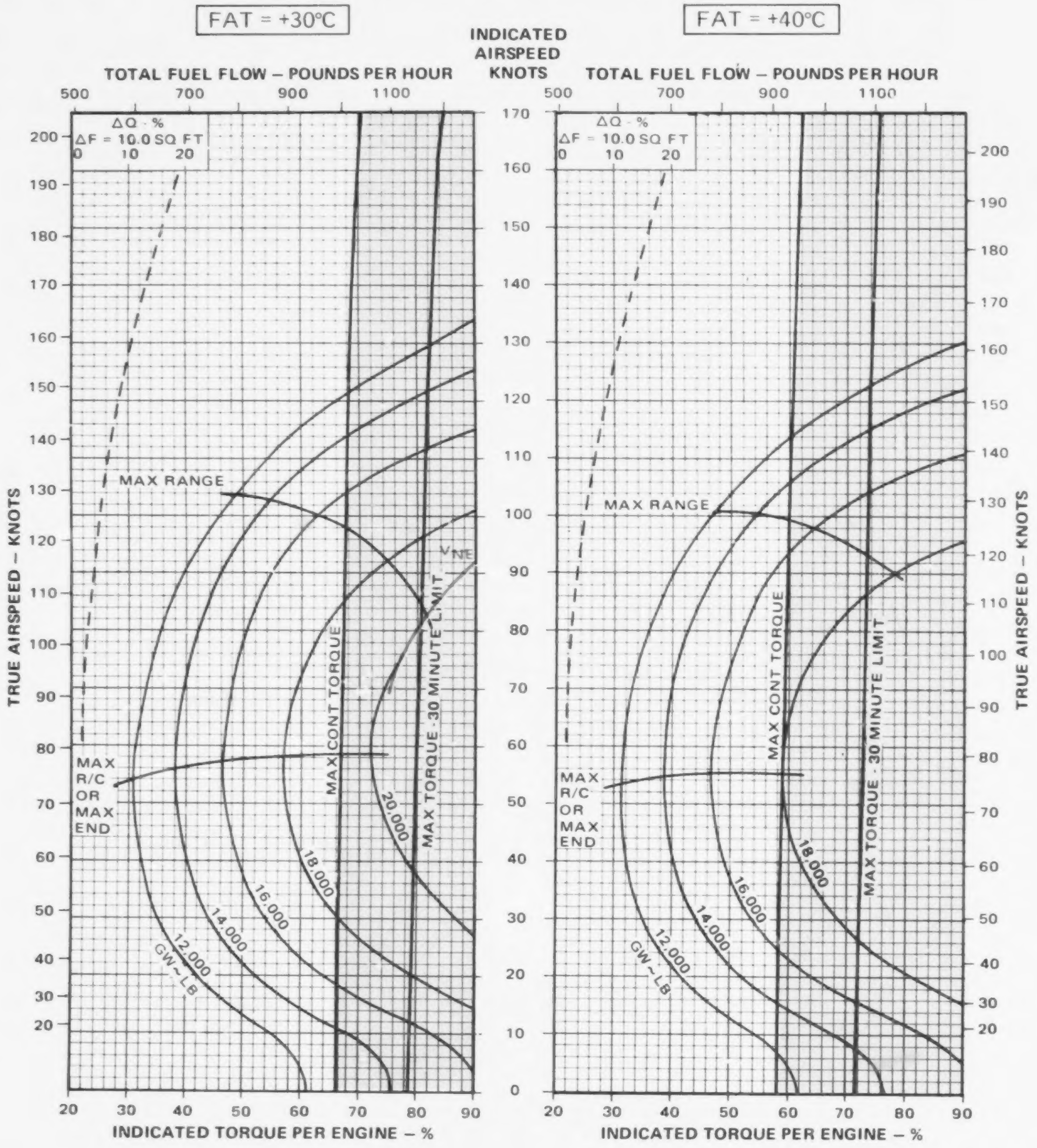
Figure 7-37. Cruise Chart, 8,000 Feet, + 10° and + 20°C

R Y

CRUISE

PRESSURE ALTITUDE - 8000 FEET

100% RPM, 8 HELLFIRE CONFIGURATION, JP-4 FUEL



R Y

MM01-159A

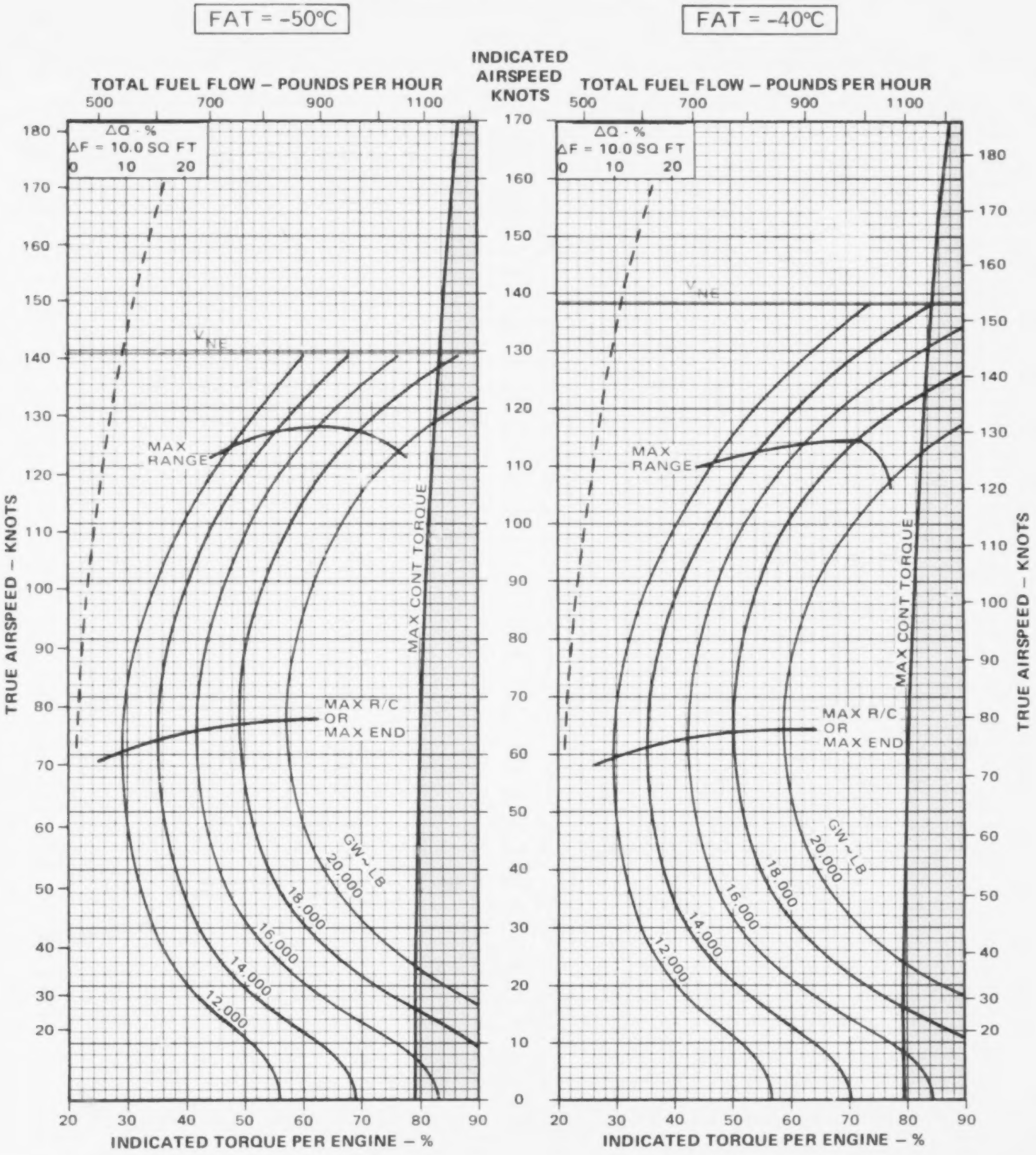
Figure 7-38. Cruise Chart, 8,000 Feet, + 30° and + 40°C

▨ ☐
R Y

CRUISE

PRESSURE ALTITUDE - 10,000 FEET

100% RPM, 8 HELLFIRE CONFIGURATION, JP-4 FUEL



▨ ☐
R Y
MM01-160

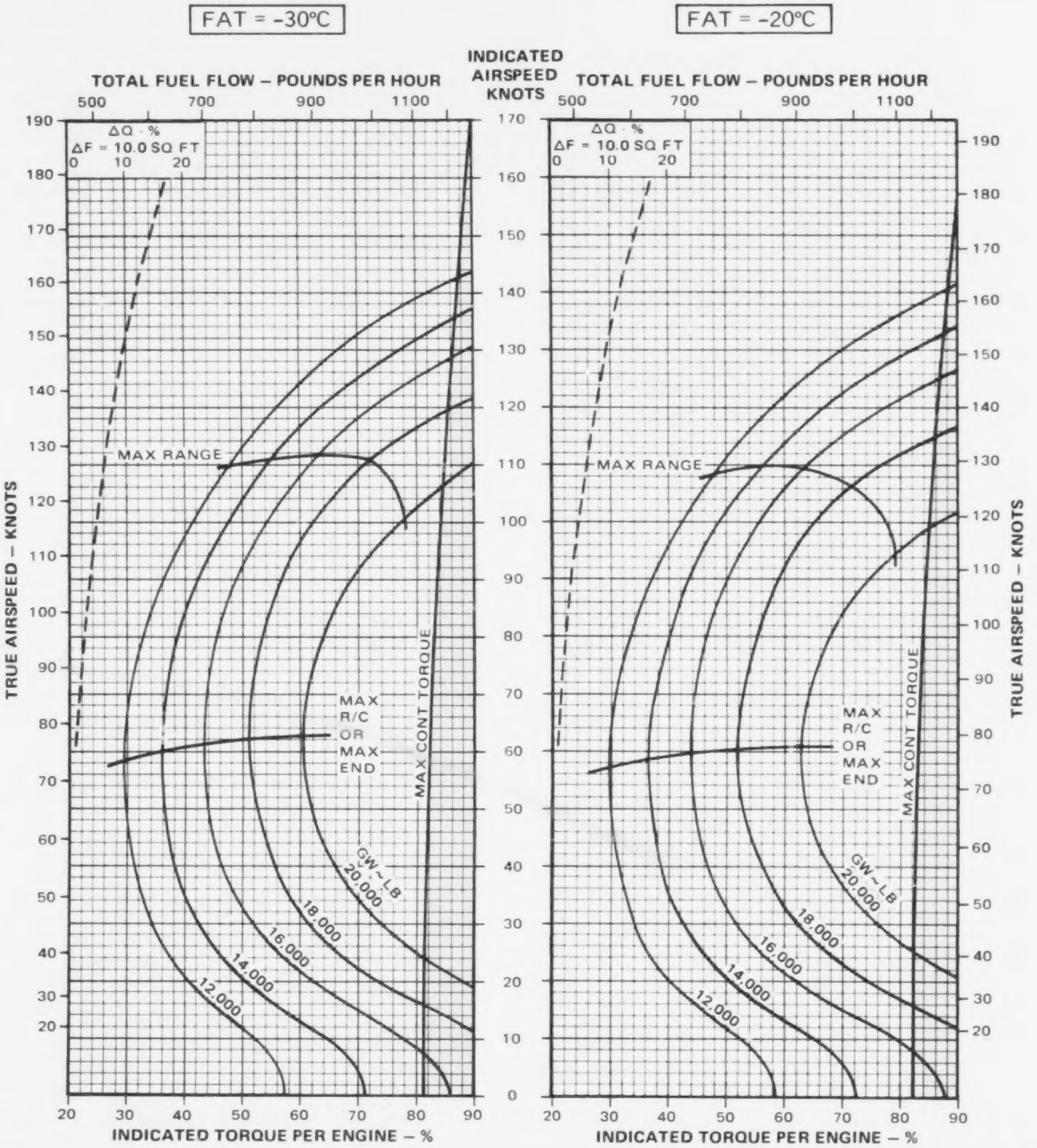
Figure 7-39. Cruise Chart, 10,000 Feet, -50° and -40°C

☐
Y

CRUISE

PRESSURE ALTITUDE - 10,000 FEET

100% RPM, 8 HELLFIRE CONFIGURATION, JP-4 FUEL



☐
Y
MM01-161

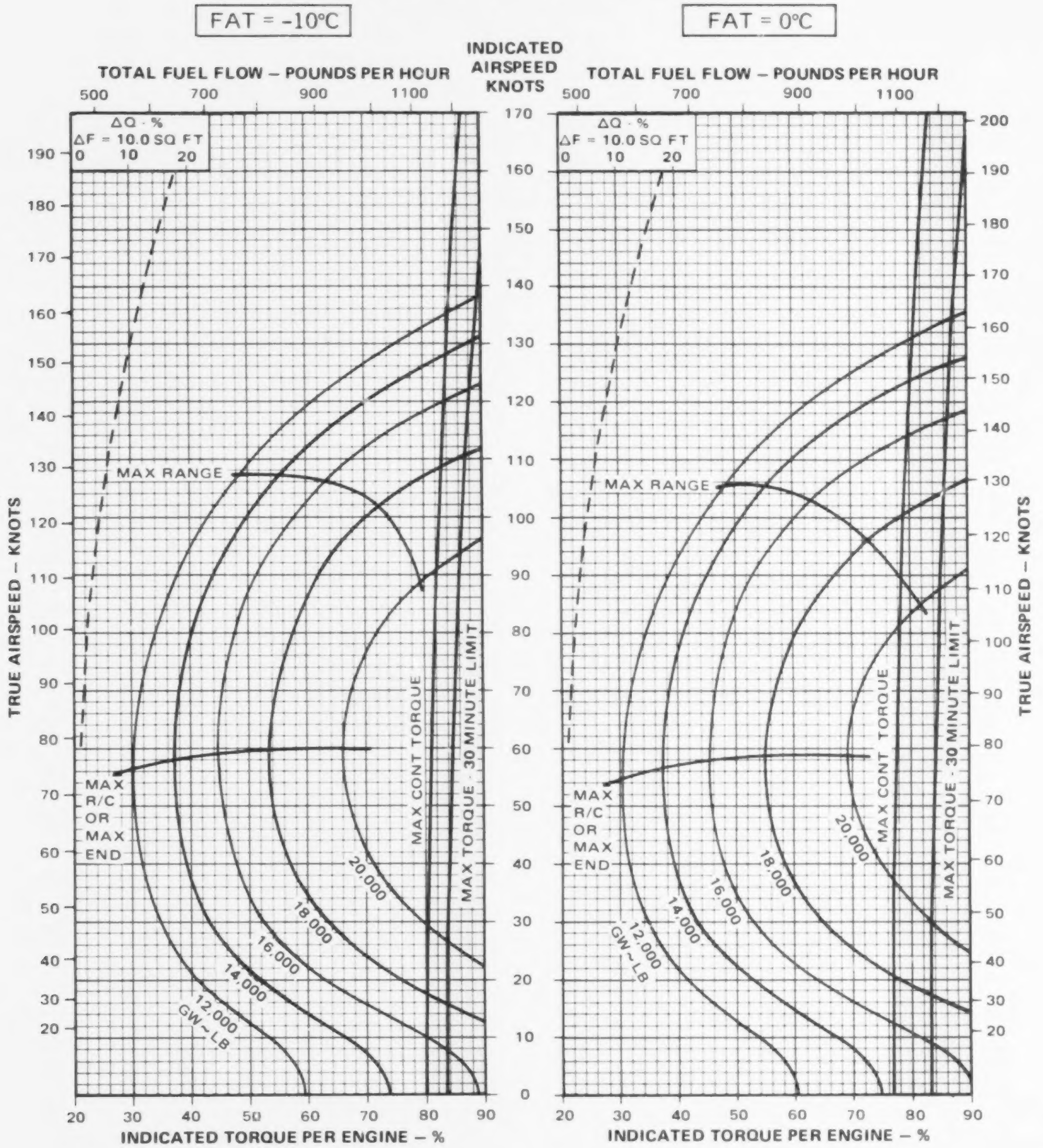
Figure 7-40. Cruise Chart, 10,000 Feet, -30° and -20°C

☐
Y

CRUISE

PRESSURE ALTITUDE - 10,000 FEET

100% RPM, 8 HELLFIRE CONFIGURATION, JP-4 FUEL



☐
Y
MM01-162

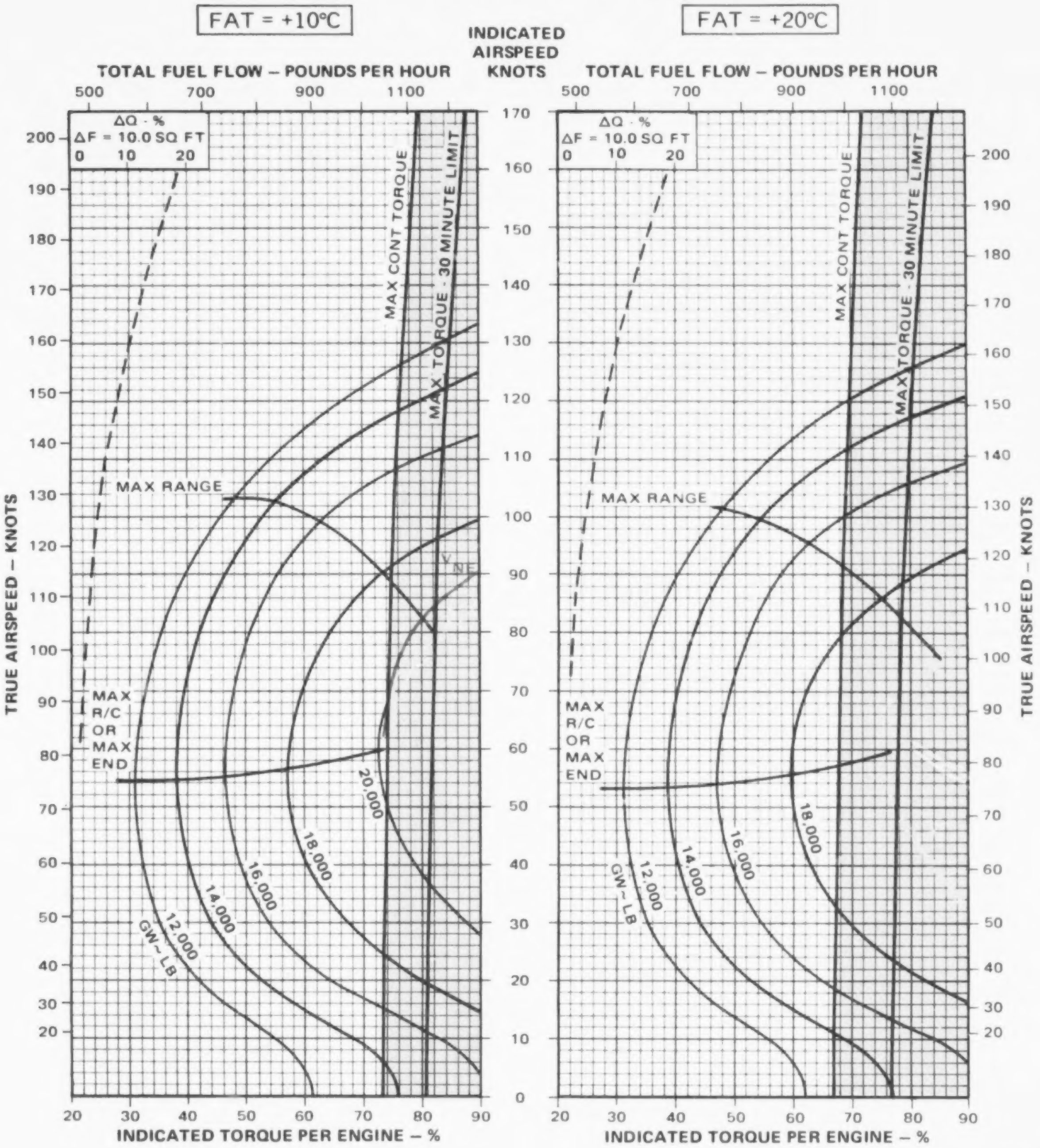
Figure 7-41. Cruise Chart, 10,000 Feet, -10° and 0°C

R Y

CRUISE

PRESSURE ALTITUDE - 10,000 FEET

100% RPM, 8 HELLFIRE CONFIGURATION, JP-4 FUEL



R Y

MM01-163A

Figure 7-42. Cruise Chart, 10,000 Feet, + 10° and + 20°C

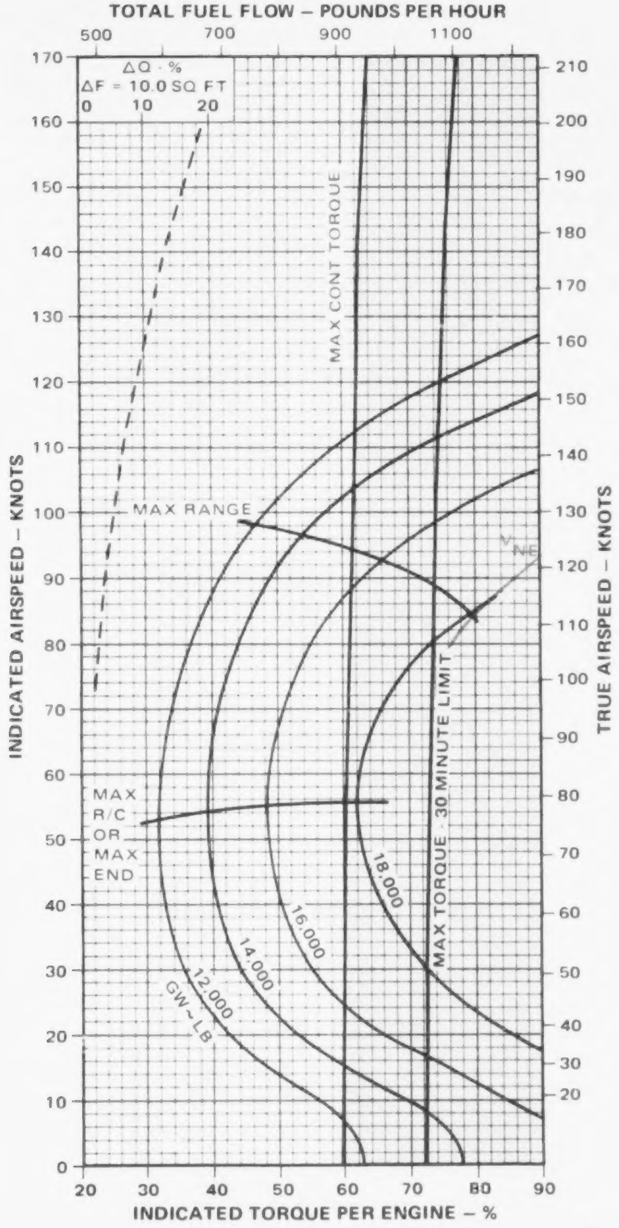
■ ☐
R Y

CRUISE

PRESSURE ALTITUDE - 10,000 FEET

100% RPM, 8 HELLFIRE CONFIGURATION, JP-4 FUEL

FAT = +30°C



■ ☐
R Y

MM01-164A

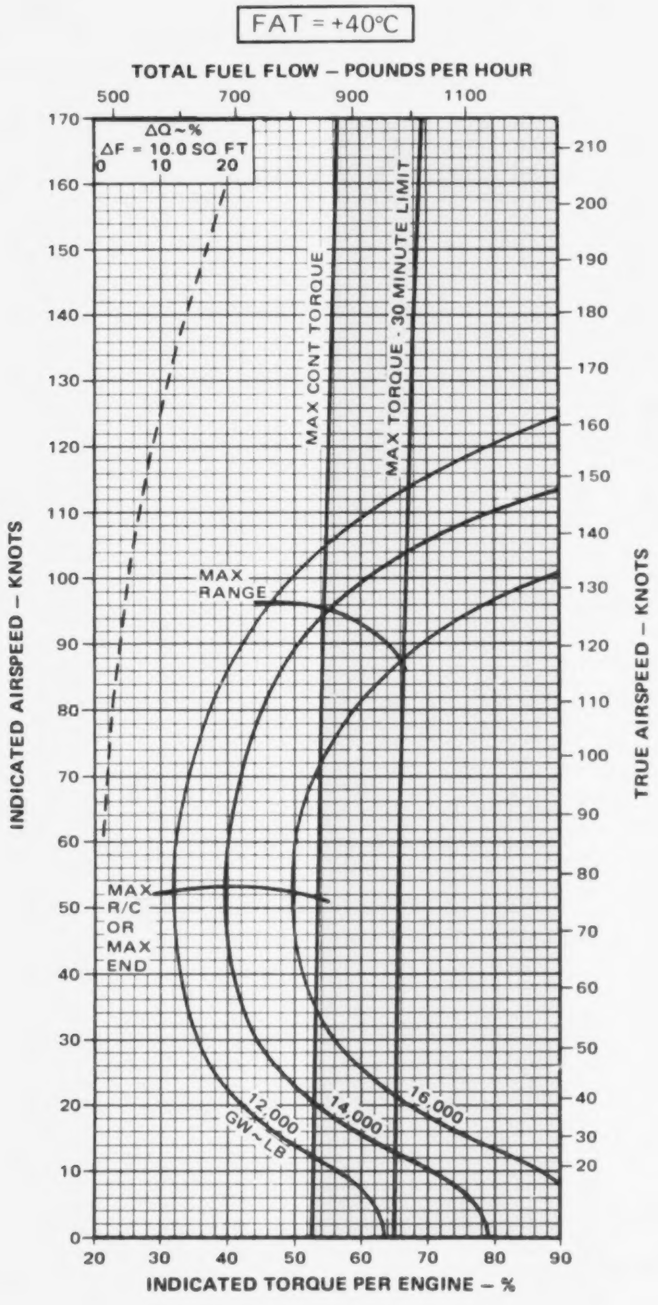
Figure 7-43. Cruise Chart, 10,000 Feet, + 30°C

☐
Y

CRUISE

PRESSURE ALTITUDE - 10,000 FEET

100% RPM, 8 HELLFIRE CONFIGURATION, JP-4 FUEL



☐
Y

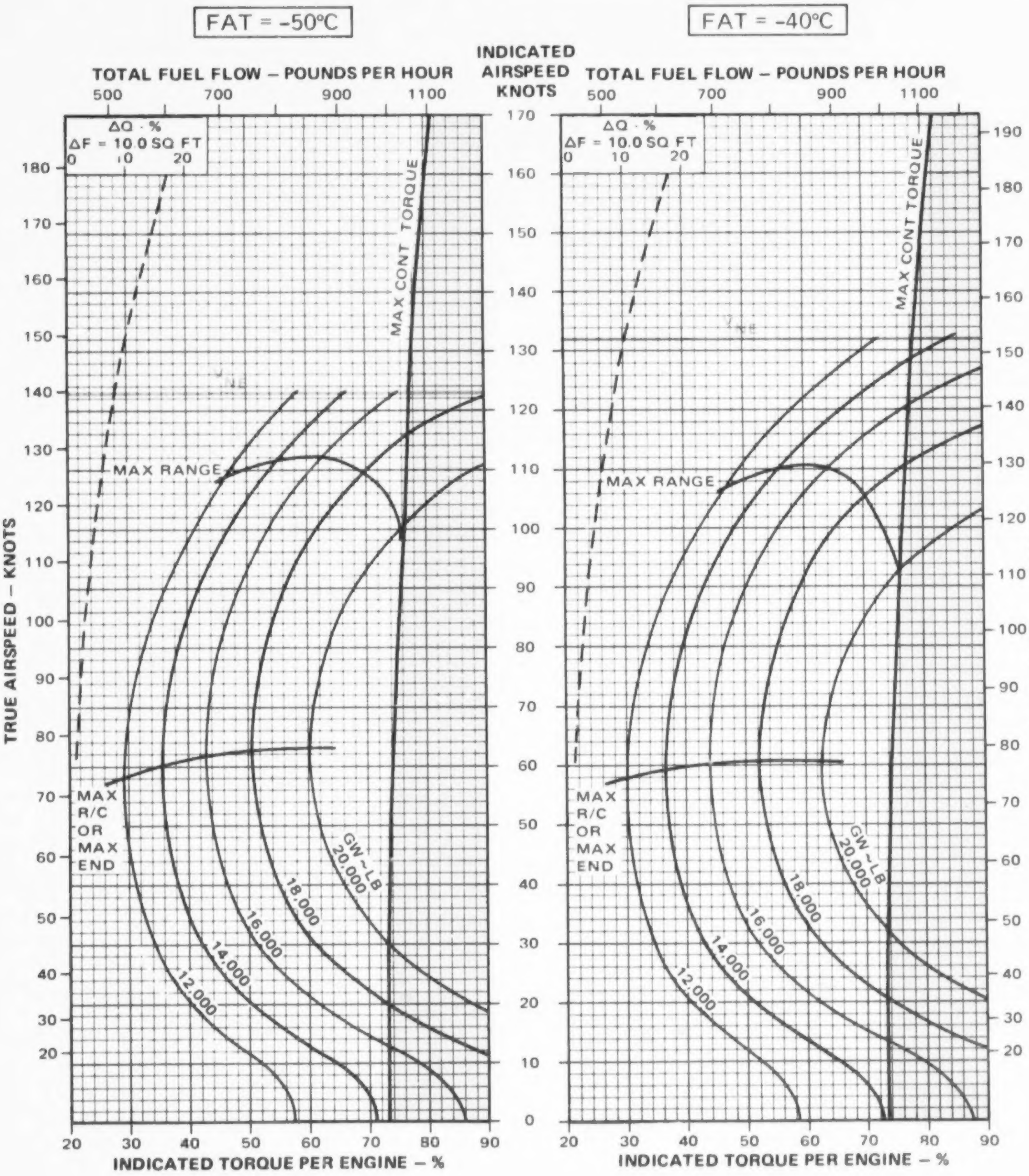
Figure 7-44. Cruise Chart, 10,000 Feet, + 40°C

▨ ☐
R Y

CRUISE

PRESSURE ALTITUDE - 12,000 FEET

100% RPM, 8 HELLFIRE CONFIGURATION, JP-4 FUEL



▨ ☐
R Y
MM01-165

Figure 7-45. Cruise Chart, 12,000 Feet, -50° and -40°C

CRUISE

PRESSURE ALTITUDE - 12,000 FEET

100% RPM, 8 HELLFIRE CONFIGURATION, JP-4 FUEL

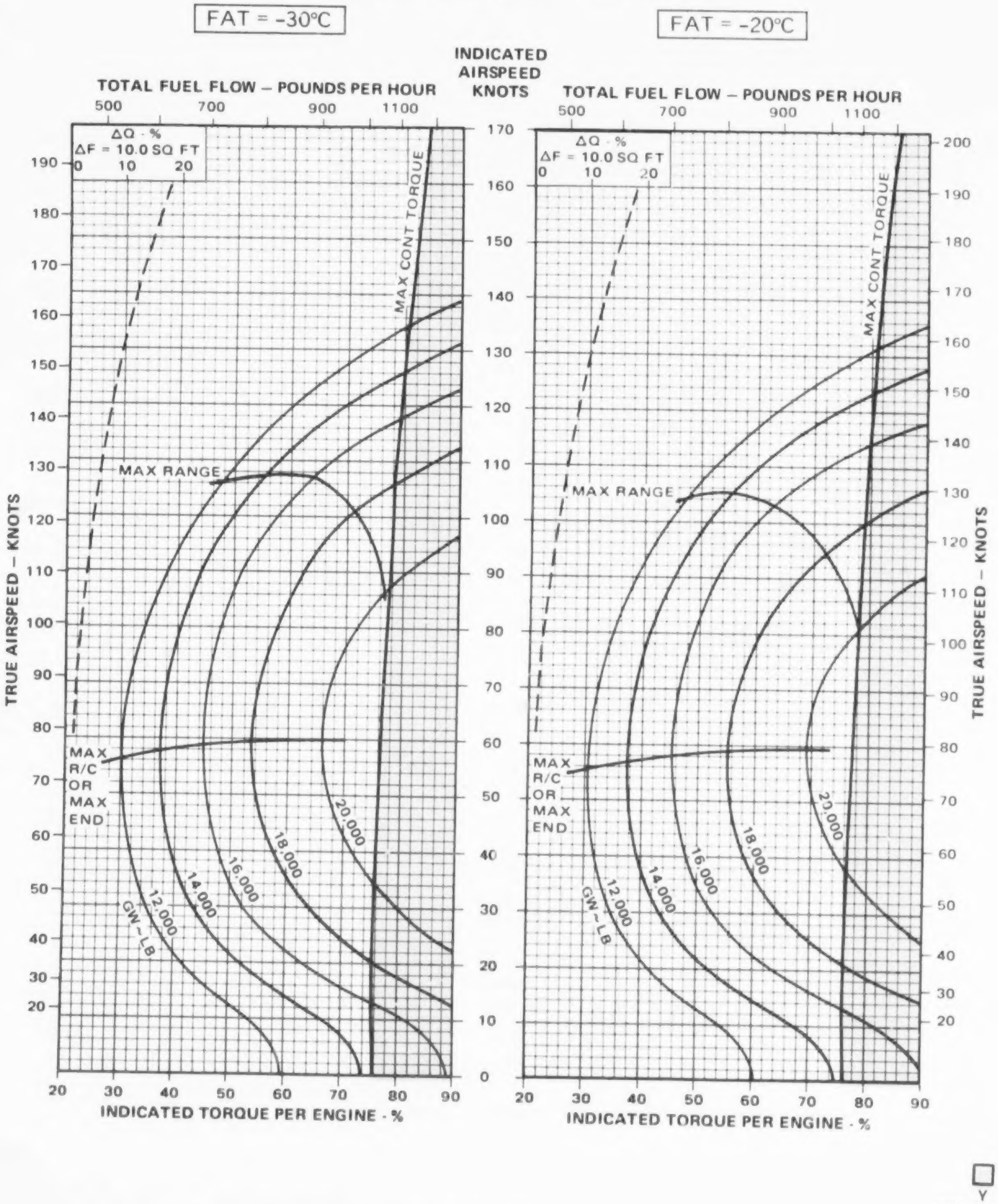


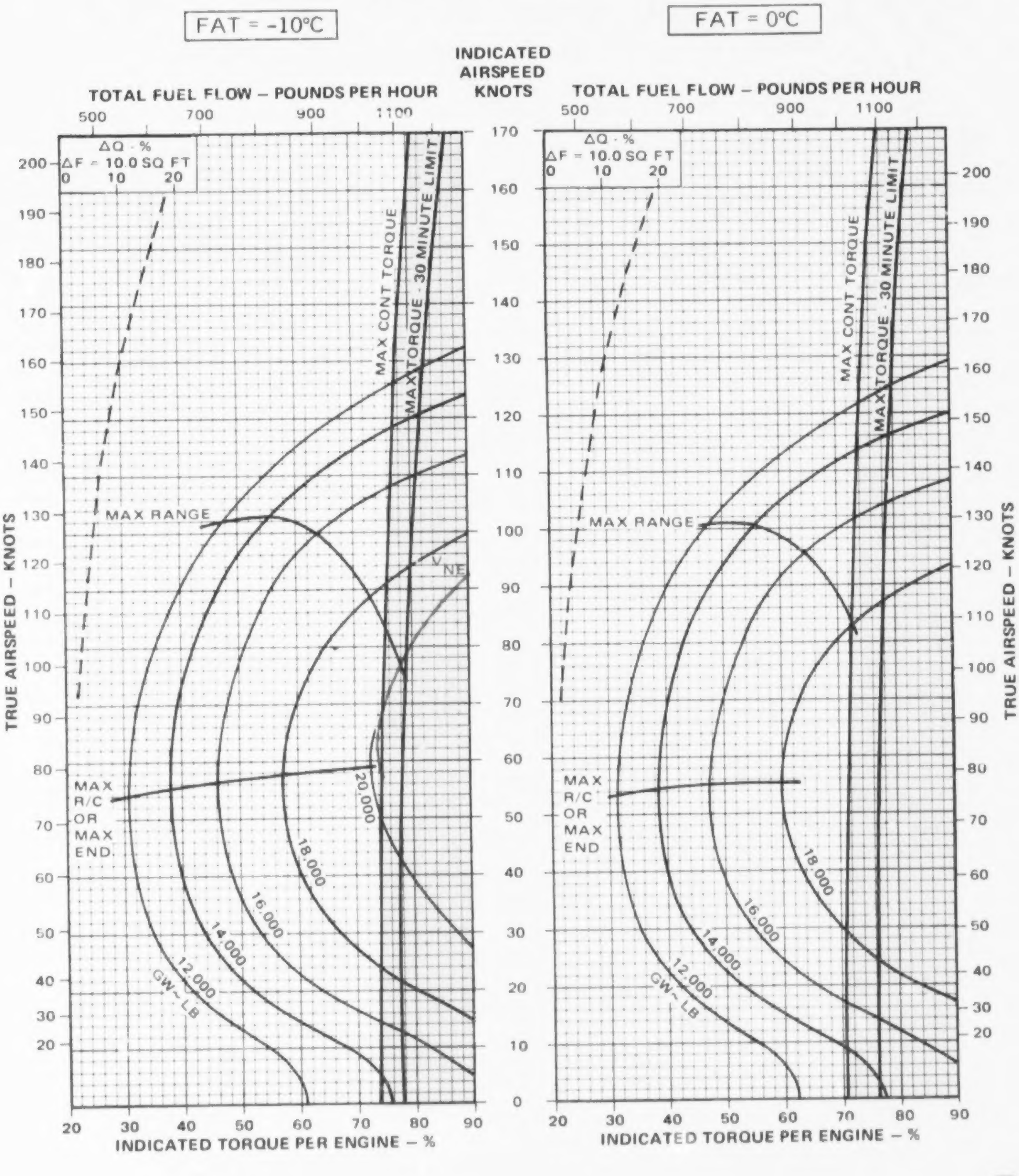
Figure 7-46. Cruise Chart, 12,000 Feet, -30° and -20°C

▨ ☐
R Y

CRUISE

PRESSURE ALTITUDE - 12,000 FEET

100% RPM, 8 HELLFIRE CONFIGURATION, JP-4 FUEL



▨ ☐
R Y

MM01-167A

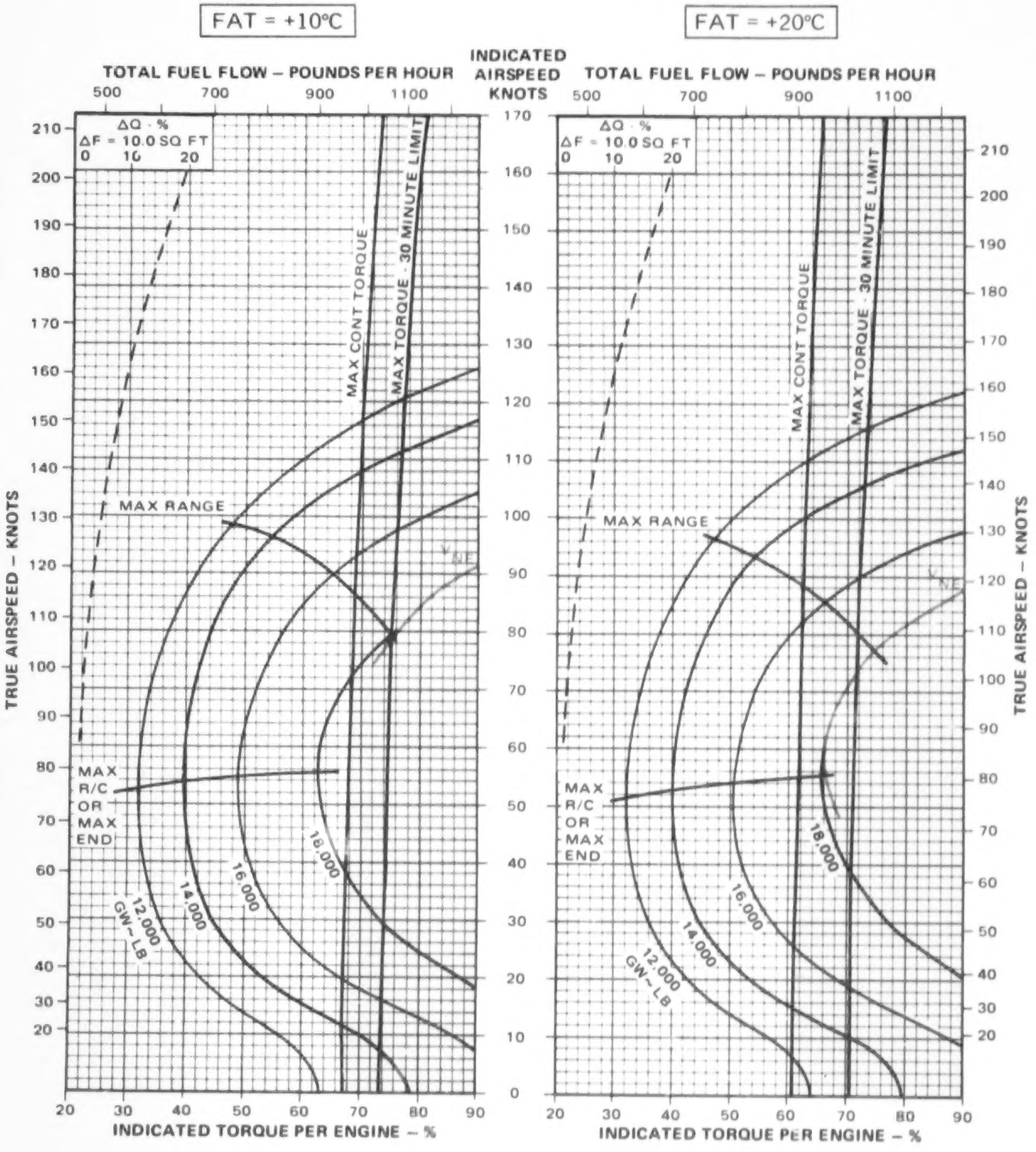
Figure 7-47. Cruise Chart, 12,000 Feet, -10° and 0°C

▨ ☐
R Y

CRUISE

PRESSURE ALTITUDE - 12,000 FEET

100% RPM, 8 HELLFIRE CONFIGURATION, JP-4 FUEL



▨ ☐
R Y

MM01-168A

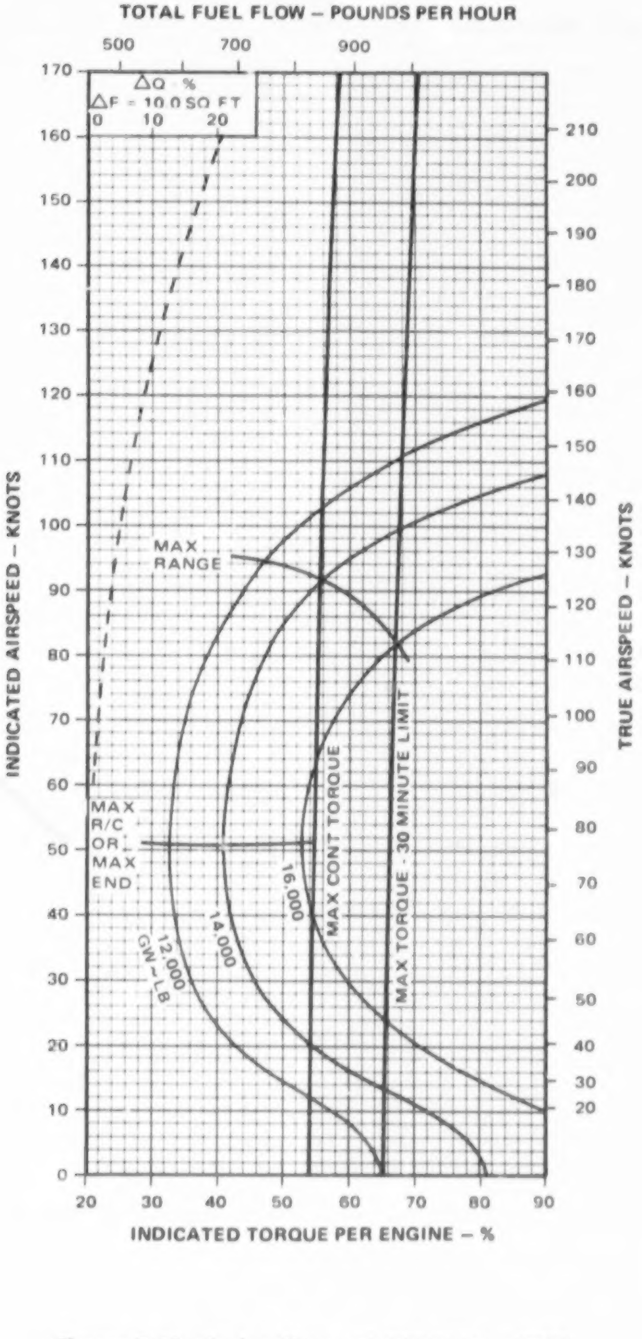
Figure 7-48. Cruise Chart, 12,000 Feet, + 10° and + 20°C

CRUISE

PRESSURE ALTITUDE - 12,000 FEET

100% RPM, 8 HELLFIRE CONFIGURATION, JP-4 FUEL

FAT = +30°C



MM01-198

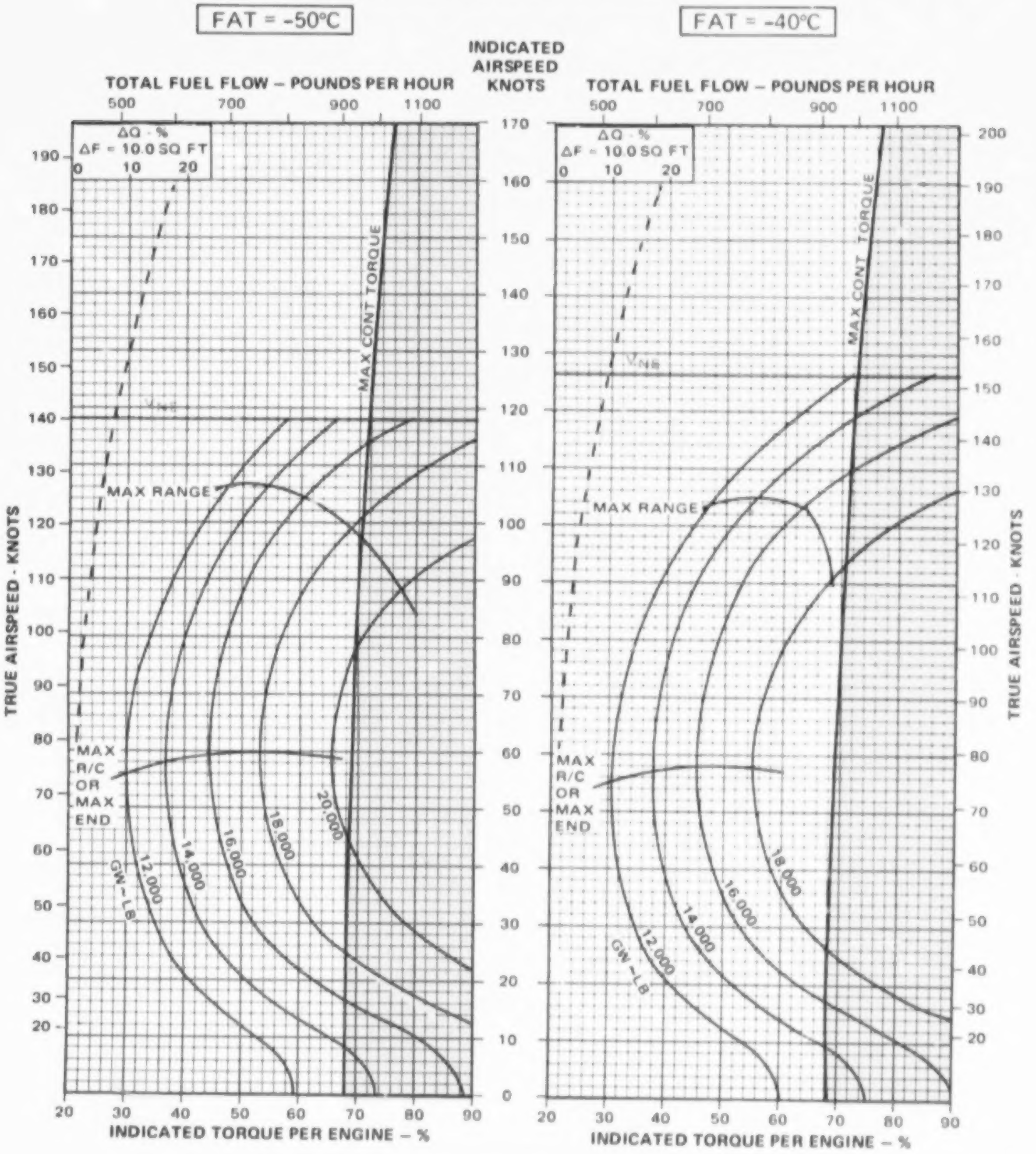
Figure 7-49. Cruise Chart, 12,000 Feet, + 30°C

🟥 □
R Y

CRUISE

PRESSURE ALTITUDE - 14,000 FEET

100% RPM, 8 HELLFIRE CONFIGURATION, JP-4 FUEL



🟥 □
R Y

MM01-169

Figure 7-50. Cruise Chart, 14,000 Feet, -50° and -40°C

CRUISE

PRESSURE ALTITUDE – 14,000 FEET

100% RPM, 8 HELLFIRE CONFIGURATION, JP-4 FUEL

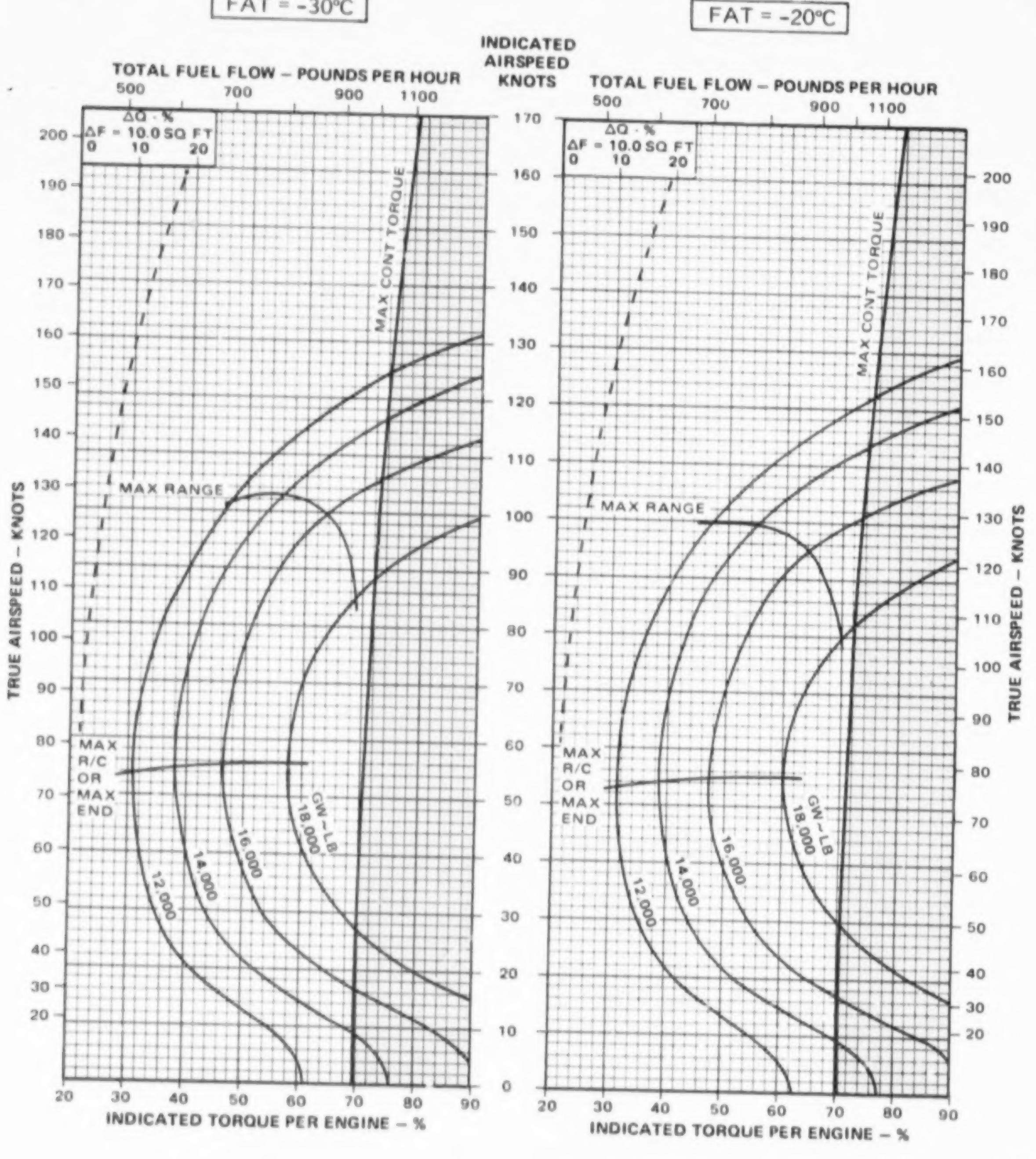
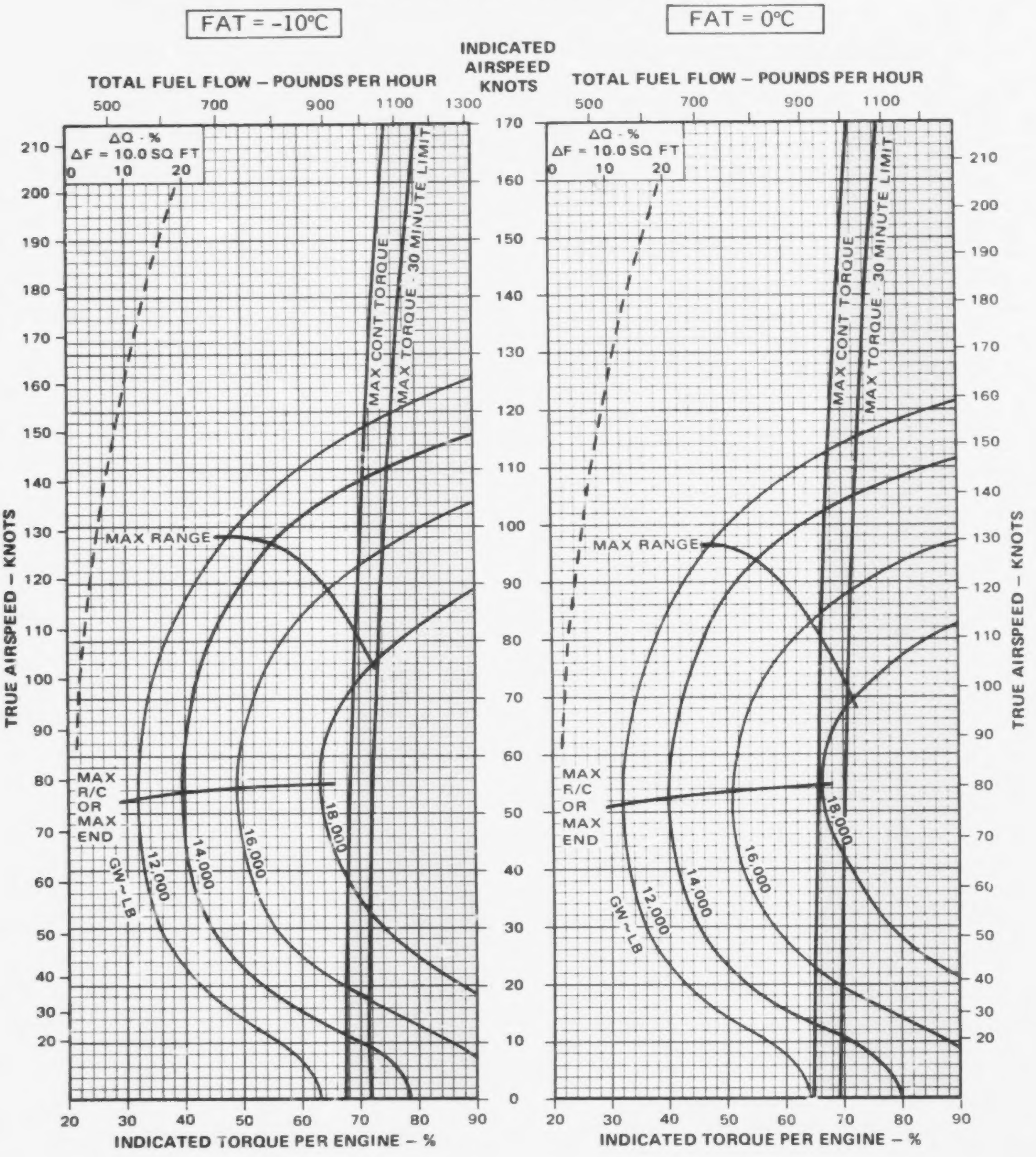


Figure 7-51. Cruise Chart, 14,000 Feet, -30° and -20°C

CRUISE

PRESSURE ALTITUDE – 14,000 FEET

100% RPM, 8 HELLFIRE CONFIGURATION, JP-4 FUEL



Y

MM01-171

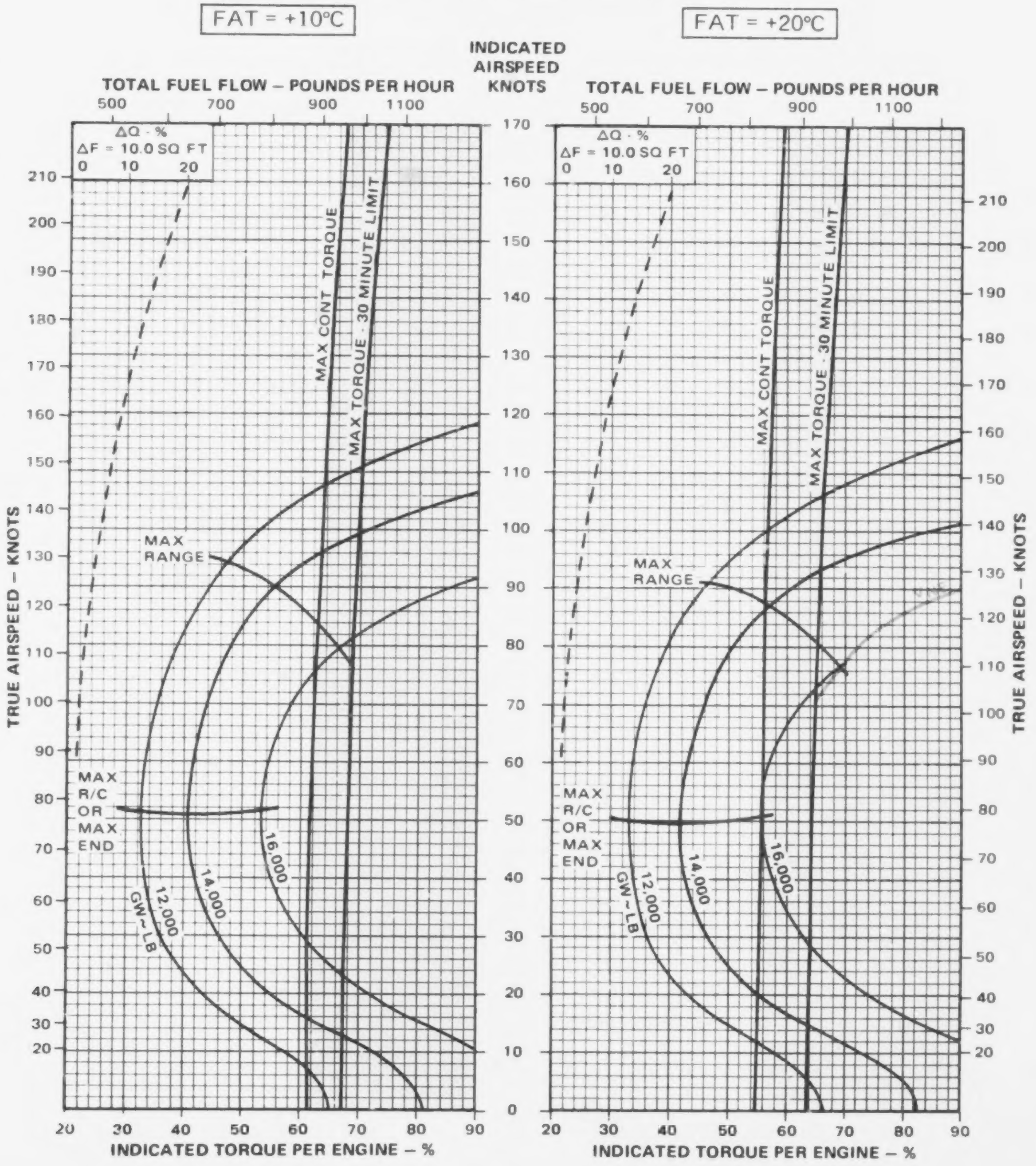
Figure 7-52. Cruise Chart, 14,000 Feet, -10° and 0°C

R Y

CRUISE

PRESSURE ALTITUDE - 14,000 FEET

100% RPM, 8 HELLFIRE CONFIGURATION, JP-4 FUEL



R Y

MM01-172A

Figure 7-53. Cruise Chart, 14,000 Feet, + 10° and + 20°C

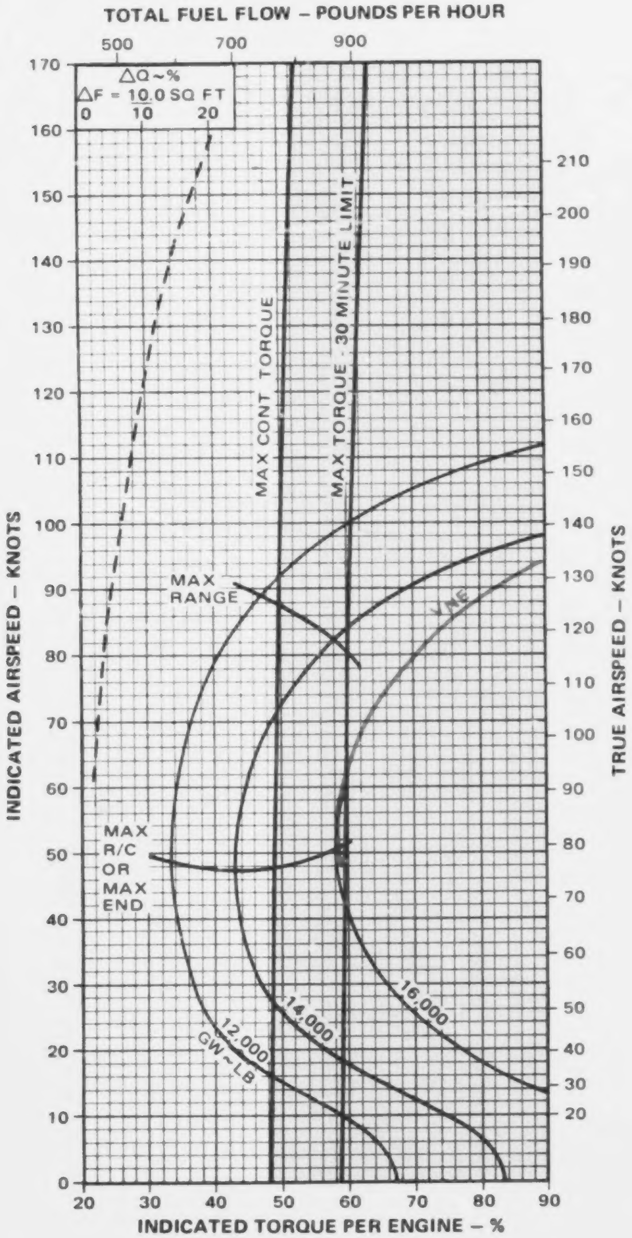
🟥☐
R Y

CRUISE

PRESSURE ALTITUDE - 14,000 FEET

100% RPM, 8 HELLFIRE CONFIGURATION, JP-4 FUEL

FAT = +30°C



🟥☐
R Y
MM01-197

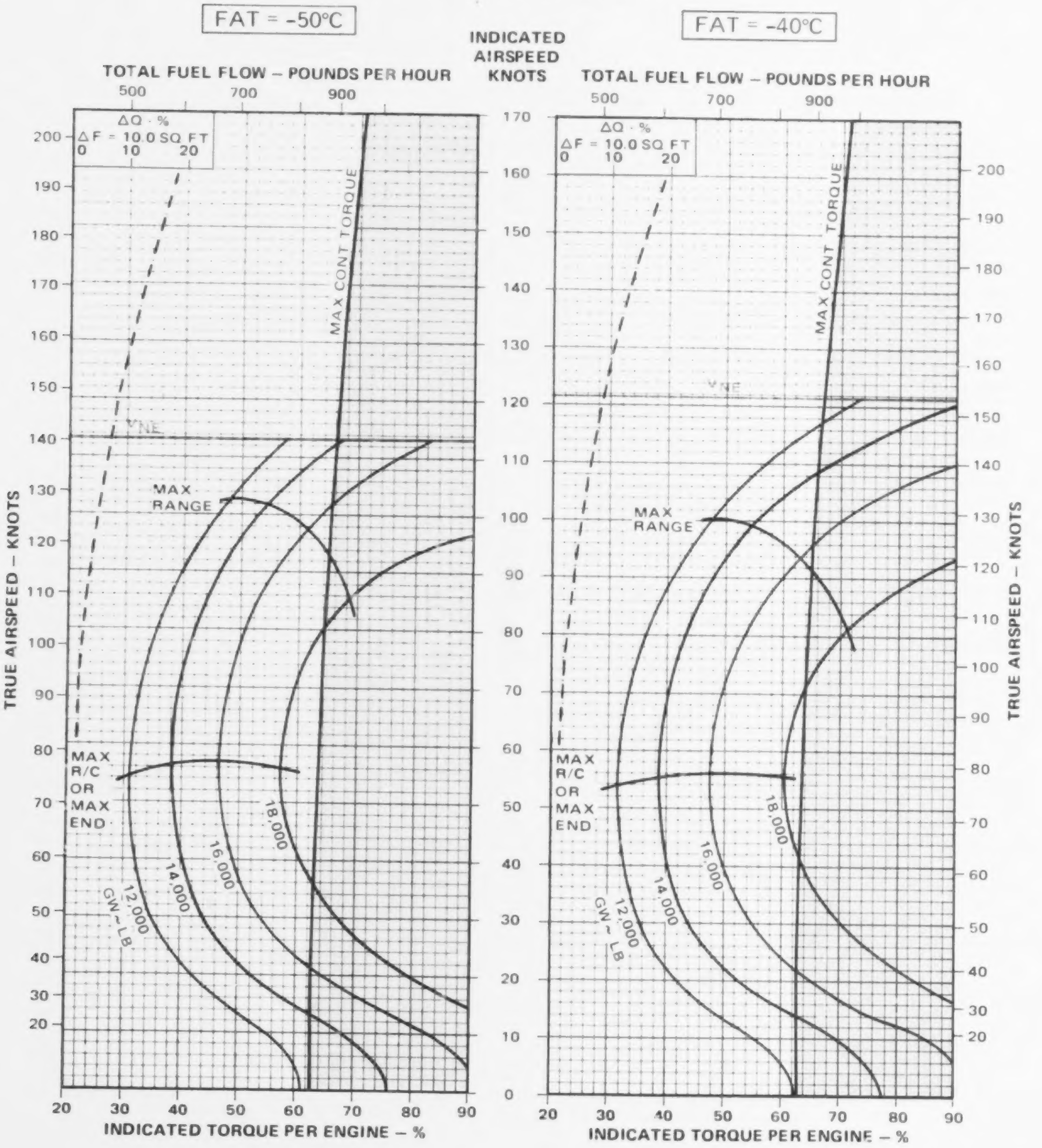
Figure 7-54. Cruise Chart, 14,000 Feet, + 30°C

■ □
R Y

CRUISE

PRESSURE ALTITUDE - 16,000 FEET

100% RPM, 8 HELLFIRE CONFIGURATION, JP-4 FUEL



■ □
R Y

MM01-173

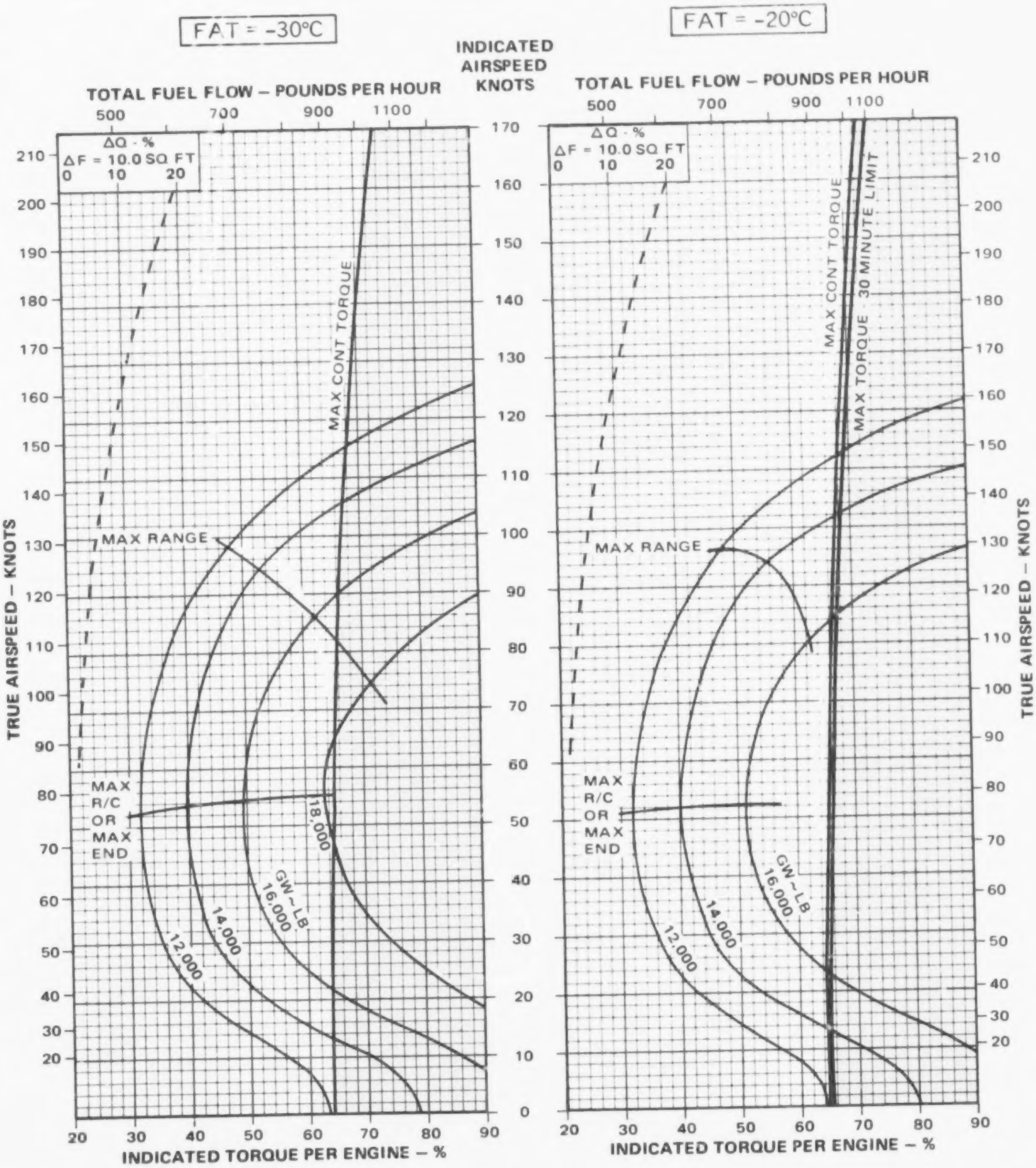
Figure 7-55. Cruise Chart, 16,000 Feet, -50° and -40°C

☐
Y

CRUISE

PRESSURE ALTITUDE - 16,000 FEET

100% RPM, 8 HELLFIRE CONFIGURATION, JP-4 FUEL



☐
Y

MM01-174

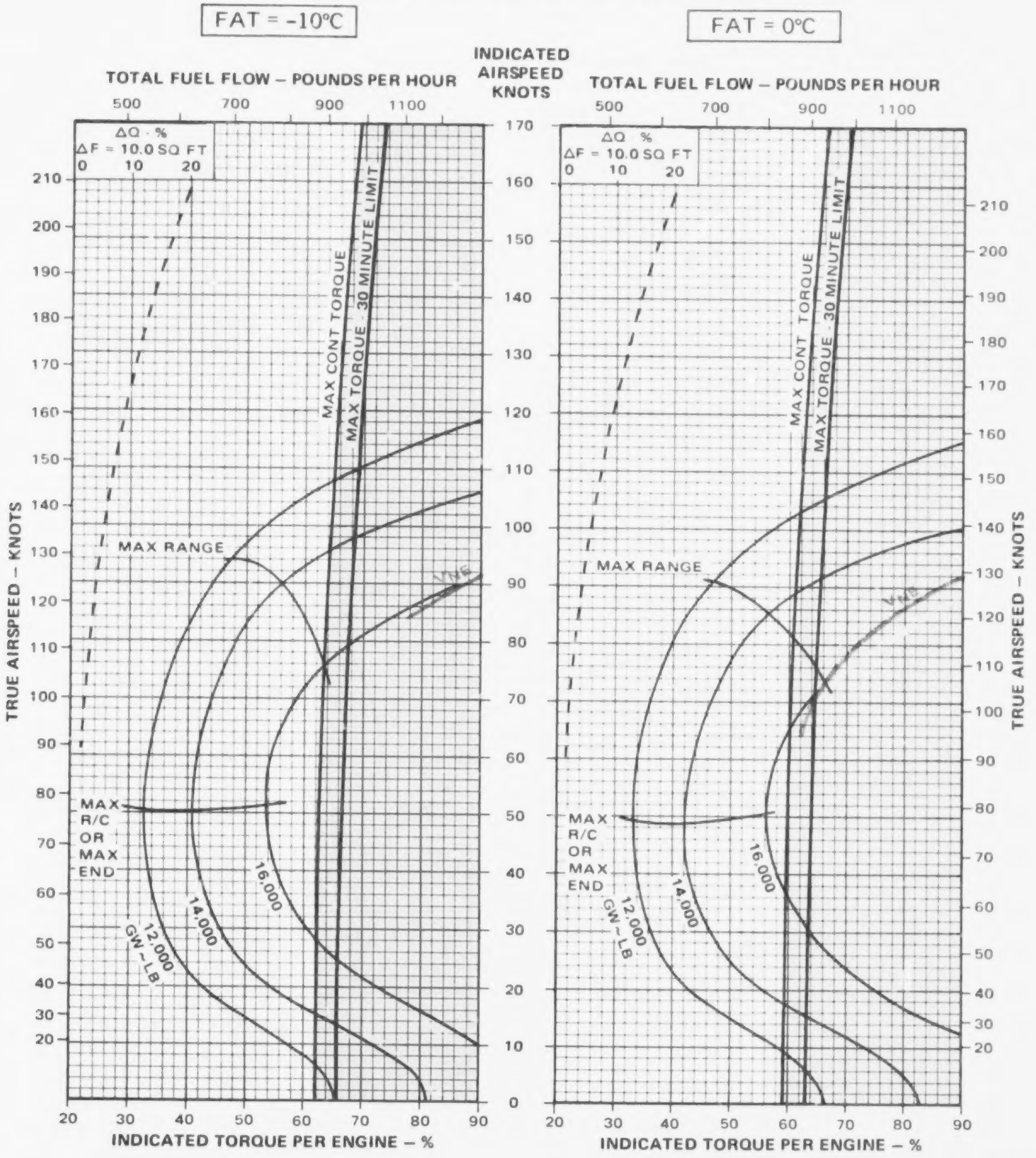
Figure 7-56. Cruise Chart, 16,000 Feet, -30° and -20°C

▨ ☐
R Y

CRUISE

PRESSURE ALTITUDE - 16,000 FEET

100% RPM, 8 HELLFIRE CONFIGURATION, JP-4 FUEL



▨ ☐
R Y
MM01-175A

Figure 7-57. Cruise Chart, 16,000 Feet, -10° and 0°C

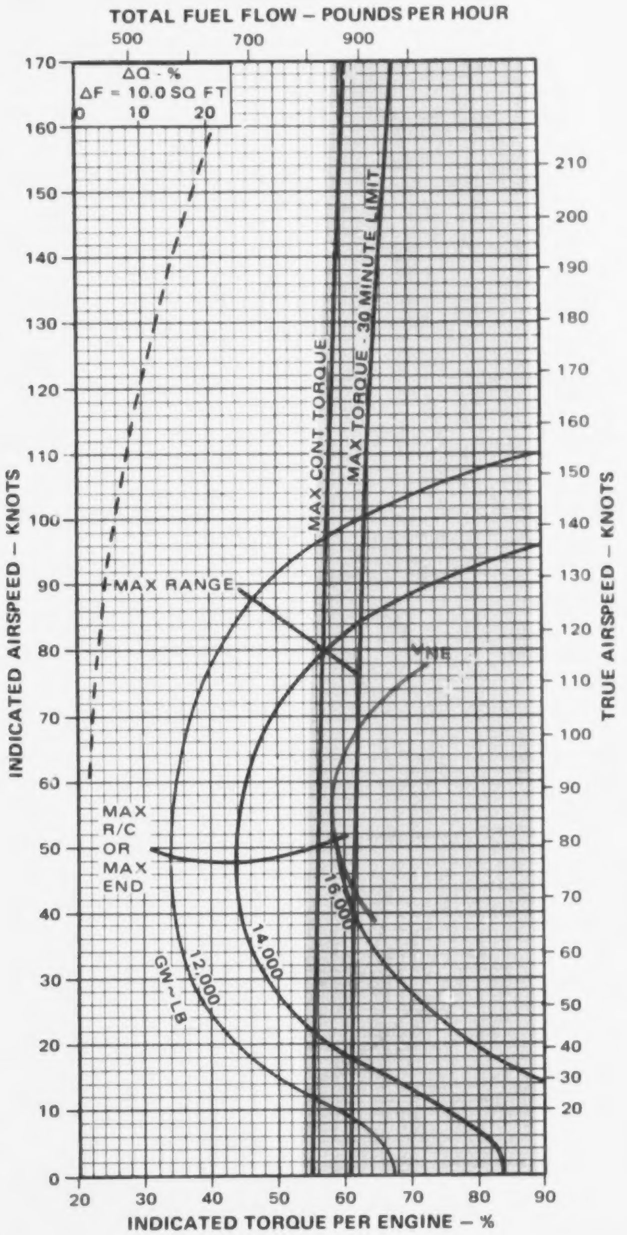
R Y

CRUISE

PRESSURE ALTITUDE – 16,000 FEET

100% RPM, 8 HELLFIRE CONFIGURATION, JP-4 FUEL

FAT = +10°C



R Y

MM01-176A

Figure 7-58. Cruise Chart, 16,000 Feet, + 10°C

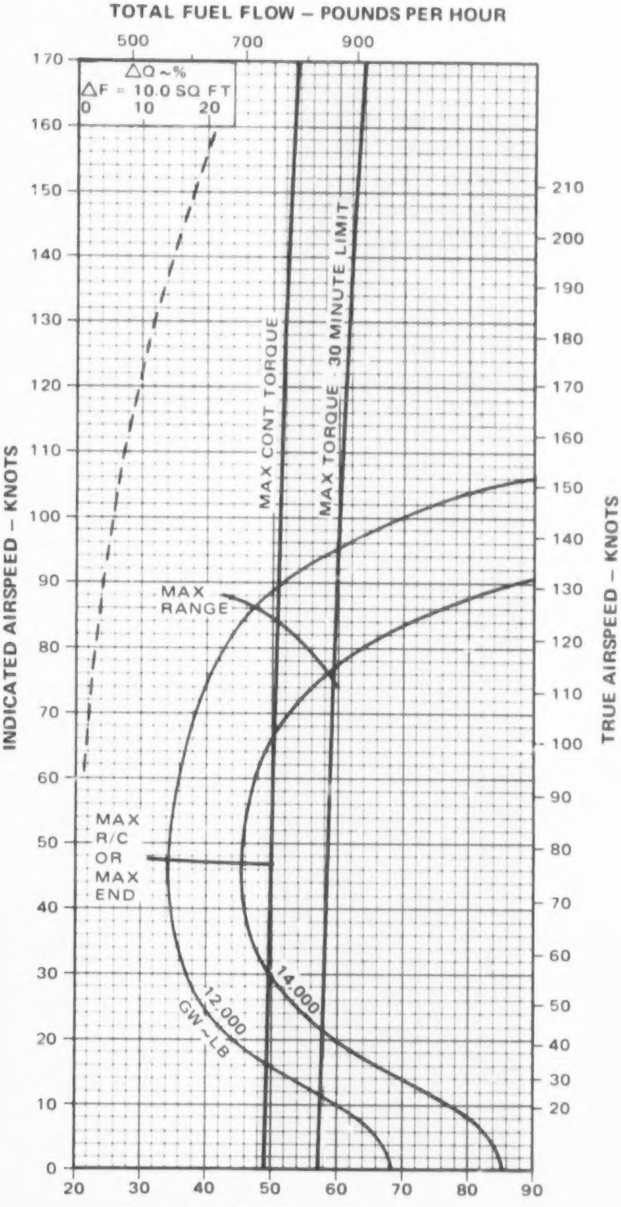
☐
Y

CRUISE

PRESSURE ALTITUDE - 16,000 FEET

100% RPM, 8 HELLFIRE CONFIGURATION, JP-4 FUEL

FAT = +20°C



☐
Y

MM01-196

Figure 7-59. Cruise Chart, 16,000 Feet, + 20°C

Section VII. DRAG

7-27. DESCRIPTION.

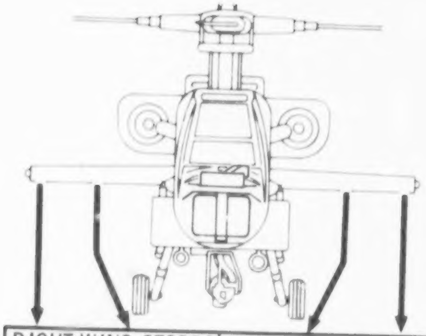
The drag chart (figure 7-60) shows the change in frontal area for each wing-stores combination that can be installed on the helicopter. The baseline configuration (primary mission) consists of one pylon and one full Hellfire launcher on each inboard stores station.

7-28. Use of Chart.

To determine the change in frontal area (ΔF) and the associated multiplying factor, it is necessary to know what combination of stores is installed. Enter the chart at the top, move down to the illustration that matches the desired combination, and then move right and read ΔF and the multiplying factor. Use the multiplying factor and data in Section VI, Cruise to determine the resulting change in torque.

7-29. Conditions.

The drag chart is based on the primary mission configuration having zero change in frontal area.

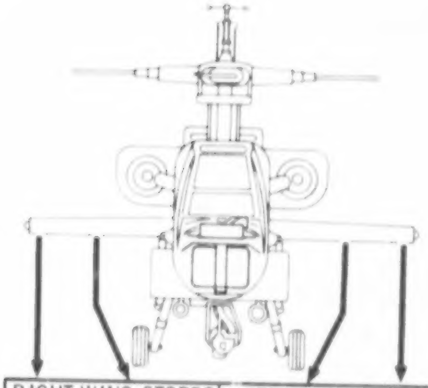


RIGHT WING STORES		LEFT WING STORES		△F (SQ. FT.)	MULTIPLYING FACTOR
OUTBOARD	INBOARD	INBOARD	OUTBOARD		
				-8.0	-8.0
▯			▯	-6.9	-0.69
	▯	▯		-6.9	-0.69
▯	▯	▯	▯	-5.7	-0.57
	●	●		-6.1	-0.61
●			●	-6.1	-0.61
	○	○		-2.1	-0.21
○			○	-2.1	-0.21
●	▯	▯	●	-4.9	-0.49
▯	●	●	▯	-4.9	-0.49
▯	○	○	▯	-0.9	-0.09
○	▯	▯	○	-0.9	-0.09
●	●	●	●	-4.2	-0.42

▯	STORES PYLON (EMPTY)
✣	STORES PYLONS PLUS HELLFIRE MISSLE LAUNCHER (LOADED WITH 4 MISSILES)
●	STORES PYLONS PLUS 19 TUBE ROCKET LAUNCHER (LOADED WITH 19 ROCKETS)
○	STORES PYLONS PLUS EXTERNAL FUEL TANK
☐	CLEAN STATION

MM01-110-1B

Figure 7-60. Drag Chart and Authorized Armament Configurations (Sheet 1 of 2)



RIGHT WING STORES		LEFT WING STORES		△F	MULTIPLYING FACTOR
OUTBOARD	INBOARD	INBOARD	OUTBOARD	(SQ. FT.)	
○	○	○	○	+5.2	+0.52
✱			✱	0 BASE LINE)	0 (BASE LINE)
	✱	✱		0 (BASELINE)	0 (BASELINE)
✱	▯	▯	✱	+1.2	+0.12
▯	✱	✱	▯	+1.2	+0.12
●	✱	✱	●	+1.9	+0.19
✱	●	●	✱	+1.9	+0.19
✱	✱	✱	✱	+9.6	+0.96

▯	STORES PYLON (EMPTY)
✱	STORES PYLONS PLUS HELLFIRE MISSLE LAUNCHER (LOADED WITH 4 MISSILES)
●	STORES PYLONS PLUS 19 TUBE ROCKET LAUNCHER (LOADED WITH 19 ROCKETS)
○	STORES PYLONS PLUS EXTERNAL FUEL TANK
☐	CLEAN STATION

MM01-110-2B

Figure 7-60. Drag Chart and Authorized Armament Configurations (Sheet 2 of 2)

Section VIII. CLIMB DESCENT

7-30. DESCRIPTION.

The climb-descent chart (figure 7-61) shows the change in torque (above and below the torque required for level flight under the same configuration, gross weight, and atmospheric conditions) to obtain a desired rate of climb or descent.

7-31. Use of Chart.

a. The primary use of the chart is illustrated by the example. To determine the change in torque, it is necessary to know the gross weight and the desired rate of climb or descent. Enter the chart at the desired rate of climb or descent, move rigfht to the known gross weight, and then move down and read the torque change. This torque change must be added to (for climb) or subtracted from (for descent) the torque rtequired for level flight (obtained from the appropriate cruise chart) to obtain a total climb or descent torque.

b. By entering the chart with a known torque change, and moving up to the known gross weight and then left, the corresponding rate of clmb or descent can also be obtained.

7-32. Conditions.

The climb-descent chart is based on 100-percent rotor rpm.

G

CLIMB-DESCENT

EXAMPLE

WANTED

CALIBRATED TORQUE CHANGE FOR DESIRED RATE OF CLIMB OR DESCENT

KNOWN OR ESTIMATED

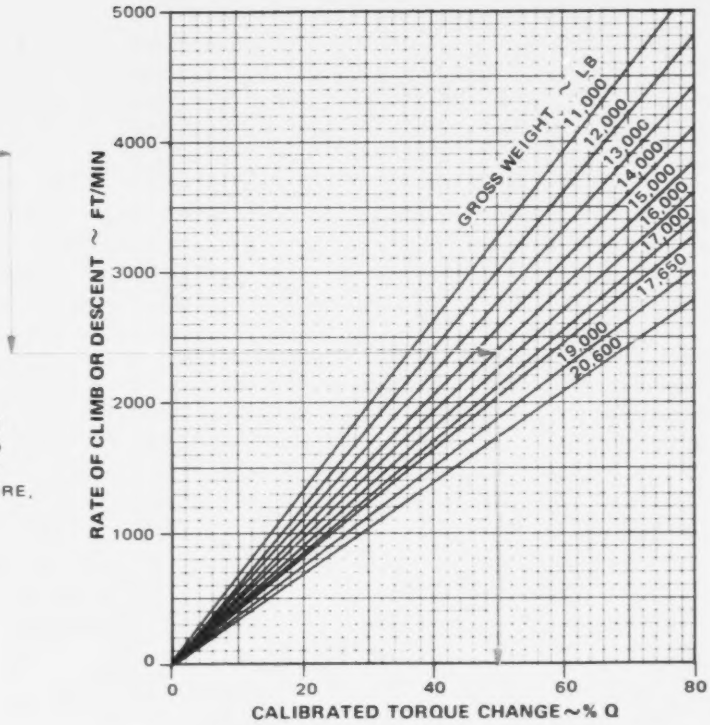
GROSS WEIGHT = 15,000 LB
DESIRED R/C = 2400 FT/MIN

METHOD

ENTER R/C HERE
MOVE RIGHT TO GROSS WEIGHT,
MOVE DOWN, READ CALIBRATED
TORQUE CHANGE = 50%

REMARK

TORQUE CHANGE IS THE DIFFERENCE BETWEEN TORQUE USED DURING CLIMB OR DESCENT AND THE TORQUE REQUIRED FOR LEVEL FLIGHT AT THE SAME CONDITIONS (ALTITUDE, TEMPERATURE, AIRSPEED, CONFIGURATION, ETC.)



G

MM01-043C

Figure 7-61. Climb-Descent Chart

best copy available

Section IX. CLIMB PERFORMANCE

7-33. DESCRIPTION.

The climb performance charts (figures 7-62 and 7-63) represent a synthesis of the cruise charts to ease estimation of the climb portion of the flight plan. The charts show relationships between gross weight, initial and final altitude and temperatures, time to climb, distance covered while climbing, and fuel expended while climbing. Two charts are available, one for climbing at maximum torque available, 30-minute limit; and the other at continuous torque available.

7-34. Use of Charts.

The primary use of the climb performance charts is illustrated by the example. To obtain the desired climb performance it is necessary to know gross weight, initial and final pressure altitudes, and initial and final free air temperatures. Enter at top left at known gross weight, move right to initial altitude, move down to free air temperature at that altitude, and move left and record time, distance, and fuel flow for that altitude. Enter again at gross weight, move right to final altitude, move down to free air temperature at that altitude, and move right and record time, distance, and fuel flow for that altitude. Subtract time, distance, and fuel-flow values of the initial altitude-temperature condition from those of the final altitude-temperature condition to find the time used to climb, distance covered, and fuel used while climbing.

7-35. Conditions.

The charts represent two climb conditions, one for maximum torque available and one for continuous torque available. Climb speed is assumed to be at 65 knots IAS, which is near the airspeed for maximum rate of climb under most atmospheric conditions. Warmup and taxiing fuel are NOT included in the fuel flow calculations. Climb performance is based on 100-percent rotor rpm.

G

CLIMB PERFORMANCE

MAXIMUM TORQUE AVAILABLE – 30 MINUTE LIMIT

100% RPM CLIMB AT 65 KIAS

EXAMPLE

WANTED

TIME TO CLIMB
FUEL USED
DISTANCE TRAVELED

KNOWN

MAXIMUM TORQUE
GROSS WEIGHT = 16,000 LB
INITIAL PRESSURE ALTITUDE = 2000 FT
FINAL PRESSURE ALTITUDE = 12,000 FT
INITIAL FAT = +30°C
ESTIMATED FINAL FAT = +10°C

METHOD

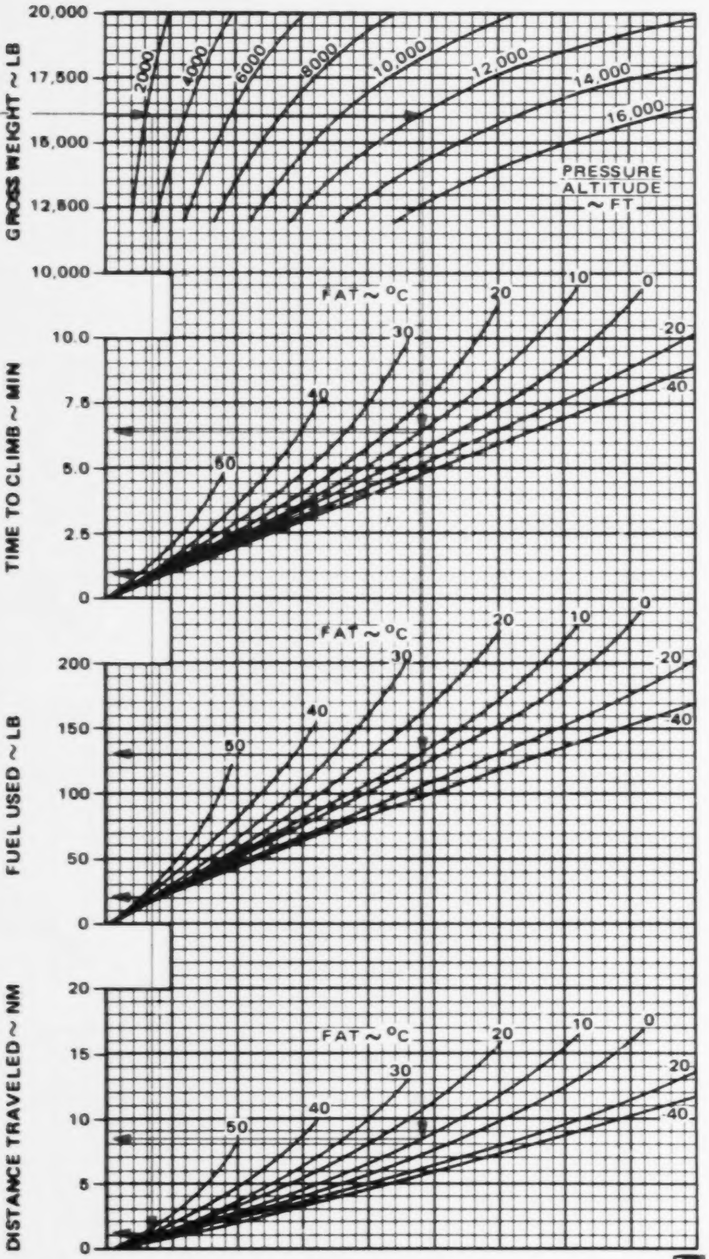
ENTER GROSS WEIGHT HERE
MOVE RIGHT TO INITIAL PRESSURE ALTITUDE.
MOVE DOWN TO INITIAL FAT
ON TIME, FUEL, AND DISTANCE CHARTS.
MOVE LEFT, READ:

TIME	=	0.8 MIN
FUEL	=	18 LB
DISTANCE	=	0.9 NM

REENTER AT SAME GROSS WEIGHT.
MOVE RIGHT TO FINAL PRESSURE ALTITUDE.
MOVE DOWN TO FINAL FAT
ON TIME, FUEL, AND DISTANCE CHARTS.
MOVE LEFT, READ:

TIME	=	6.3 MIN
FUEL	=	128 LB
DISTANCE	=	8.2 NM

TIME TO CLIMB = 6.3 - 0.8 = 5.5 MIN
FUEL USED = 128 - 18 = 110 LB
DISTANCE COVERED = 8.2 - 0.9 = 7.3 NM



G
MM01-112A

Figure 7-62. Climb Performance Chart, Maximum Torque

G

CLIMB PERFORMANCE

CONTINUOUS TORQUE AVAILABLE

100% RPM CLIMB AT 65 KIAS

EXAMPLE

WANTED

TIME TO CLIMB
FUEL USED
DISTANCE TRAVELED

KNOWN

CONTINUOUS TORQUE
GROSS WEIGHT = 16,000 LB
INITIAL PRESSURE ALTITUDE = 2000 FT
FINAL PRESSURE ALTITUDE = 12,000 FT
INITIAL FAT =+ 30°C
ESTIMATED FINAL FAT =+10°C

METHOD

ENTER GROSS WEIGHT HERE
MOVE RIGHT TO INITIAL PRESSURE ALTITUDE.
MOVE DOWN TO INITIAL FAT ON TIME, FUEL, AND DISTANCE CHARTS.
MOVE LEFT, READ:

TIME = 1.1 MIN
FUEL = 22 LB
DISTANCE = 1.3 NM

REENTER AT SAME GROSS WEIGHT.
MOVE RIGHT TO FINAL PRESSURE ALTITUDE.
MOVE DOWN TO FINAL FAT ON TIME, FUEL, AND DISTANCE CHARTS.
MOVE LEFT, READ:

TIME = 7.5 MIN
FUEL = 146 LB
DISTANCE = 10.2 NM

TIME TO CLIMB = 7.5 - 1.1 = 6.4 MIN
FUEL USED = 146 - 22 = 124 LB
DISTANCE COVERED = 10.2 - 1.3 = 8.9 NM

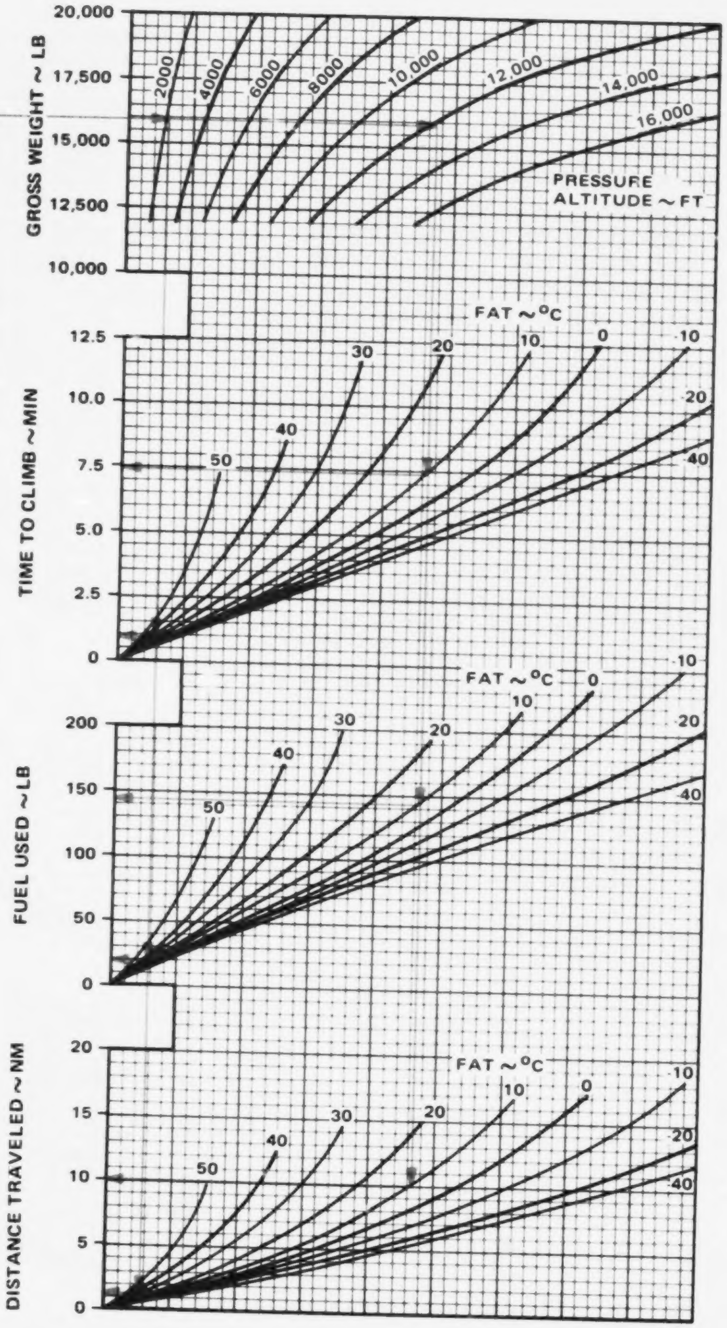


Figure 7-63. Climb Performance Chart, Continuous Torque

G

MM01-042A

Information on pages 7-79 and 7-80 deleted.

Section X. GROUND FUEL FLOW

7-36. Description

The ground fuel flow chart (figure 7-64) shows the fuel flow for engine idle and 100-percent rotor rpm with flat pitch.

7-37. Use of Chart.

The primary use of the chart is illustrated by the example. To determine engine idle fuel flow or fuel flow at 100-percent rotor rpm with flat pitch, it is necessary to know the pressure altitude and free air temperature. Enter at the pressure altitude, move right to the FAT on the desired curve, and then move down and read fuel flow on the bottom scale. Fuel flow data for cruise power conditions is shown on the cruise charts in Section VI.

7-38. Conditions.

This chart is based on the use of JP-4 fuel.

G

GROUND FUEL FLOW

JP-4 FUEL, INSTALLATION LOSSES INCLUDED

IDLE FUEL FLOW
AH-64A
T700-GE-701

EXAMPLE

WANTED

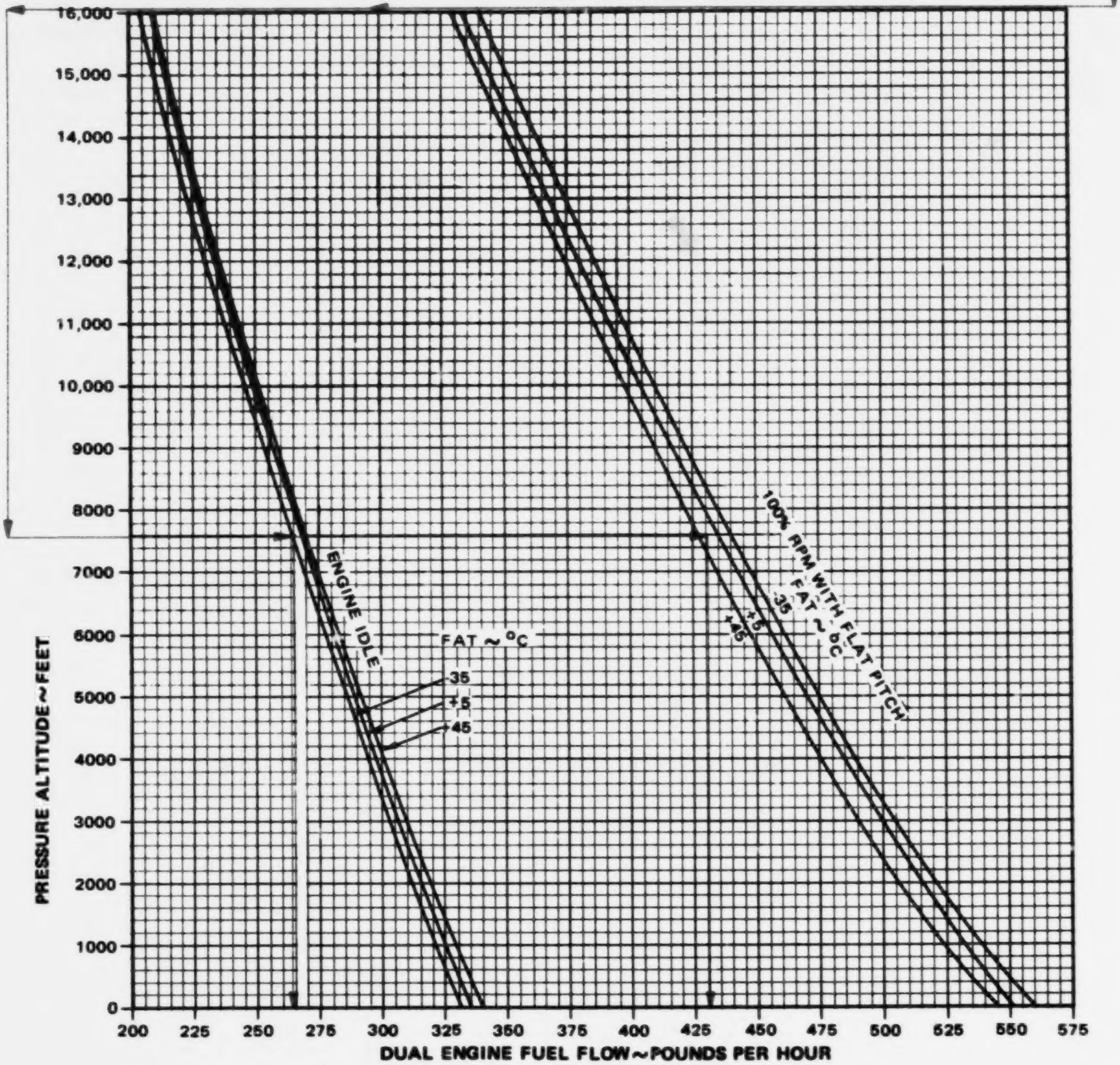
FUEL FLOW AT ENGINE IDLE AND AT 100% ROTOR RPM WITH FLAT PITCH

KNOWN

PRESSURE ALTITUDE = 7600
FAT = +5°C

METHOD

ENTER AT 7600 FEET PRESSURE ALTITUDE MOVE RIGHT TO (ENGINE IDLE) FAT OF+5°C. MOVE DOWN TO READ DUAL ENGINE IDLE FUEL FLOW OF 268 POUNDS PER HOUR. REENTER 7600 FEET PRESSURE ALTITUDE MOVE RIGHT TO (100% RPM WITH FLAT PITCH) FAT OF+5°C. MOVE DOWN TO READ FUEL FLOW OF 434 POUNDS PER HOUR FOR 100% RPM WITH FLAT PITCH.



G

MM01-045A

Figure 7-64. Ground Fuel-Flow Chart

CHAPTER 8

NORMAL PROCEDURES

Section I. MISSION PLANNING

8-1. MISSION PLANNING.

Mission planning begins when the mission is assigned, and extends to the preflight check of the helicopter. It includes, but is not limited to, checks of operating limits and restrictions: weight, balance, and loading; performance; publications; flight plan; and crew briefings. The pilot in command shall ensure compliance with the contents of this manual that are applicable to the mission.

8-2. AVIATION LIFE SUPPORT EQUIPMENT (ALSE).

All aviation life support equipment required for mission; e.g., helmets, gloves, survival vests, survival kits, etc., shall be checked.

8-3. CREW DUTIES/RESPONSIBILITIES.

a. PILOT. The pilot in command is responsible for all aspects of mission planning, preflight, and operation of the helicopter. He will assign duties and functions to all other crewmembers as required. Prior to or during preflight, the pilot will brief the copilot on items pertinent to the mission; e.g., performance data, monitoring of instruments, communications, and emergency procedures.

b. COPILOT. The copilot must be familiar with the pilot duties. The copilot will assist the pilot as directed.

8-4. Crew Briefings.

A crew briefing shall be conducted to ensure a thorough understanding of individual and team responsibilities. The briefing should include, but not be limited to, copilot/gunner and ground crew responsibilities, and the coordination necessary to complete the mission in the most efficient manner. A review of visual signals is desirable when ground guides do not have direct voice communications link with the crew.

Section II. OPERATING PROCEDURES AND MANEUVERS

8-5. OPERATING PROCEDURES AND MANEUVERS.

This section deals with normal procedures. It includes all steps necessary for safe, efficient operation of the helicopter from the time a preflight check begins until the flight is completed and the helicopter is parked and secured. Unique feel, helicopter characteristics, and reaction of the helicopter during various phases of operation and the techniques and procedures used for taxiing, taking off, climbing, etc., are described, including precautions to be observed. Your flying experience is recognized; therefore, basic flight principles are avoided. Only the duties of the minimum crew necessary for the actual operation of the helicopter are included. Mission equipment checks are contained in Chapter 4, MISSION EQUIPMENT. Procedures specifically related to instrument flight that are different from normal procedures are covered in this section, following normal procedures. Descriptions of functions, operations, and effects of controls are covered in Section IV, FLIGHT CHARACTERISTICS, and are repeated in this section only when required for emphasis. Checks that must be performed under adverse environmental conditions, such as desert and cold-weather operations, supplement normal procedures checks in this section and are covered in Section V, ADVERSE ENVIRONMENTAL CONDITIONS.

8-6. SYMBOLS DEFINITION.

Items which apply only to night or only to instrument flying shall have an "N" or an "I", respectively, immediately preceding the check to which it is pertinent. The symbol "O" shall be used to indicate "if installed". Those duties which are the responsibility of the copilot, will be indicated by a circle around the step number; i.e., 4 . The symbol star " " indicates an operational check is required. Operational checks are contained in the performance section of the condensed checklist. The symbol asterisk "*" indicates that performance of step is mandatory for all thru-flights. The asterisk applies only to checks performed prior to takeoff. Placarded items such as switch and control labels appear in bold face uppercase.

8-7. CHECKLIST.

Normal procedures are given primarily in checklist form, and amplified as necessary in accompanying paragraph form, when a detailed description of a procedure or maneuver is required. A condensed version of the amplified checklist, omitting all explanatory text, is contained in the operator's checklist. To provide for easier cross-referencing, the procedural steps in the checklist are numbered to coincide with the corresponding numbered steps in this manual

8-8. PREFLIGHT CHECK.

The pilot's walk-around and interior checks are outlined in the following procedures. The preflight check is not intended to be a detailed mechanical inspection. The steps that are essential for safe helicopter operation are included. The preflight may be made as comprehensive as conditions warrant at the discretion of the pilot.

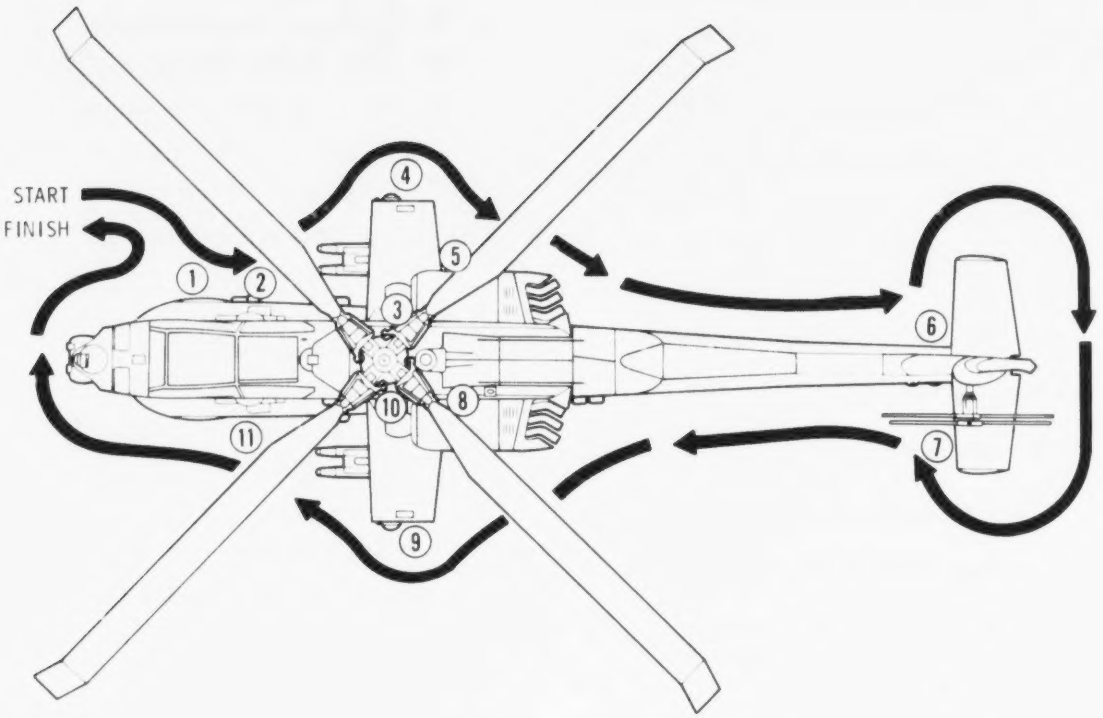
8-9. BEFORE EXTERIOR CHECK.

WARNING

Do not preflight until armament systems are safe.

*1. Helicopter covers, locking devices, tie-downs and grounding cables – removed and stowed. Pylon safety pins – installed.

2. Cockpit safety – General.
    a. Battery switch – OFF (CPG BAT ORIDE – NRML)
    b. Interior canopy jettison pins – Installed.
    c. Engine fire handles – In.



EXTERIOR CHECK

AREA 1 RIGHT SIDE - UNDERSIDE FUSELAGE
AREA 2 RIGHT SIDE - LOWER CENTER FUSELAGE
AREA 3 RIGHT SIDE - MAST AREA
AREA 4 RIGHT SIDE - LOWER CENTER FUSELAGE AND WING
AREA 5 RIGHT SIDE - REAR CENTER FUSELAGE
AREA 6 RIGHT SIDE - AFT FUSELAGE/EMPENNAGE
AREA 7 LEFT SIDE - AFT FUSELAGE/EMPENNAGE
AREA 8 LEFT SIDE - REAR CENTER FUSELAGE
AREA 9 LEFT SIDE - LOWER CENTER FUSELAGE AND WING
AREA 10 LEFT SIDE - MAST AREA
AREA 11 LEFT SIDE - CREW STATION AND LOWER CENTER FUSELAGE

MM01-025C

Figure 8-1. Exterior Inspection Diagram

d. APU fire handle - In.

e. APU control switch - OFF.

3. Armament subsystems - Safe as follows:

PILOT

a. MASTER ARM switch - OFF.

b. STORES JETT switches - OFF.

CPG

c. CPG ARM switch - OFF.

d. PLT / GND ORIDE switch - OFF.

4. Cockpit - General.

a. Ignition key - In and ON.

b. First aid kits - Installed.

c. Seat cushions - Condition.

d. Restraint system - Condition.

e. Canopy - Check.

f. Loose equipment - Secured.

5. Publications - As required by DA PAM 738-751; locally required forms and publications, and availability of Operator's Manual.

6. Fuel sample - Check for first flight of day.

8-10. EXTERIOR CHECK.

See figure 8-1.

8-11. RIGHT SIDE - UNDER SIDE FUSELAGE (AREA 1).

1. M-230E1, 30mm gun turret - Check.

a. Gun mounting - Check.

b. Feed chute - Check.

2. Searchlight - Check.

8-12. RIGHT SIDE - LOWER CENTER FUSELAGE (AREA 2).

1. Radar warning antenna - Check.
2. Forward avionics bay - Check.
3. Static port - Unobstructed.
4. Right main landing gear - Check.
*5. Refueling panel - Check and secure door.
6. Forward gravity fuel cap - Secure.
7. Single point fuel access - Secure.

8-13. RIGHT SIDE - MAST (AREA 3).

*1. Main transmission - Check oil level
*2. Nose gearbox - Check oil level, oil cap secured, cowling secure.
3. Engine inlet - Unobstructed.
*4. Engine oil level - Check and secure door.
5. Upper flight controls and swashplate - Check.
6. Main rotor head and blades - Check.

8-14. RIGHT SIDE - WING (AREA 4).

1. Wing - Check.

O 2. Pylons - Check.

NOTE

When icing conditions exist, or are predicted and Hellfire operations are expected, launcher arm/safe switch located on each Hellfire launcher must be manually placed in the ARM position prior to liftoff. It is possible for this switch to be rendered inoperative by icing.

O 3. HELLFIRE - Check as follows.

a. Launcher ARM / SAFE switch - As required.

b. Launcher mounting - Check that aft and forward attach lugs are secure to rack. Rack swaybrace bolts firmly against launcher swaybrace pads.

c. Electrical connector - Check that HELLFIRE harness cannon plug is connected to launcher. Jettison quick-disconnect lanyard is attached to connector plug and rack.

d. Missile installation – Check that each missile is seated and hold back latch is locked.

O 4. Rocket launcher – Check as follows:

   a. Launcher mounting – Check aft and forward attach lugs are secure to rack and rack swaybrace bolts are firmly against launcher.

   b. Electrical connector – Check that rocket harness connector plug is connected to launcher. Jettison quick disconnect lanyard is attached to connector plug and rack.

   c. Launcher – Check launcher exterior and tube interiors for damage and corrosion.

   d. Rocket installation – Check that rocket aft end is secure in launcher tube aft detent. Note number and zones of rocket loading.

   e. Igniter arms – Check for damage and corrosion. Arms in contact with rockets.

■ O 5. External fuel tanks - Check.

6. Pitot tube – Check tube unobstructed.

7. Wing lighting – Check condition of anti-collision, navigation and formation lights.

8. Ammunition bay access – Secure.

8-15. RIGHT SIDE – REAR CENTER FUSELAGE (AREA 5).

NOTE

Ensure that Nacelle Access Doors are properly latched and secured.

1. Nacelle fire louvers – Check open.

*2. APU oil level – Check and secure door.

3. Aft gravity fuel cap – Check security

4. Aft avionics bay – Check.

5. APU exhaust – Check.

6. IR suppressor / engine exhaust – Check.

*7. Utility hydraulic accumulator – Check hydraulic pressure (2600 psi minimum).

8. Equipment stowage compartment – Check and secure door.

9. External power receptacle – Access door closed if external power source is not used.

10. Belly antennas – Check.

8-16. RIGHT SIDE – AFT FUSELAGE / EMPENNAGE (AREA 6).

1. Aft tailboom and empennage (right side) – Check.

2. Stabilator – Check.

3. Tail landing gear – Check.

8-17. LEFT SIDE – AFT FUSELAGE / EMPENNAGE (AREA 7).

1. Empennage (left side) – Check.

2. Tail rotor, controls, hub, and blades – Check.

3. Stabilator – Check.

8-18. LEFT SIDE – REAR CENTER FUSELAGE (AREA 8).

NOTE

Ensure that Nacelle Access Doors are properly latched and secured.

1. Aft tailboom – Check.

2. Transmission deck catwalk doors – Check security.

3. Equipment stowage compartment – Check and secure door.

4. IR suppressor / engine exhaust – Check.

5. Aft storage bay – Check and secure door.

6. Nacelle fire louvers – Check open.

*7. Fire extinguisher disc – Check that yellow disc visible.

8. Ammunition bay access – Secure.

8-19. LEFT SIDE – WING (AREA 9).

1. Wing – Check.
2. Wing lighting – Check anti-collision, navigation, and formation lights.
3. Pitot tube – Check unobstructed.

O 4. Pylons – Check.
O 5. HELLFIRE – Check, same as right side.
O 6. Rocket launcher – Same as right side.
O 7. External fuel tanks - Check.

8-20. LEFT SIDE – MAST (AREA 10).

*1. Main transmission – Check oil level.
*2. Nose gearbox – Check oil level, oil cap secured, and cowling secured.
3. Engine inlet – Unobstructed.
4. Engine oil level – Check and secure door.
5. Upper flight controls and swashplate – Check.
6. Main rotor head and blades – Check.
7. Air data sensor – Check.

8-21. LEFT SIDE – LOWER CENTER FUSELAGE AND NOSE (AREA 11).

1. Canopy – Check.
2. OAT gauge extension – Check security.
3. Static port – Unobstructed.
4. Utility HYD accumulator – Check.
5. Left main landing gear – Check.
6. Static ground cable – Check.
7. Forward avionics bay – Check.
8. Radar warning antenna – Check.

NOTE

When icing conditions exist, ensure that TADS/PNVS gear teeth are free of ice.

9. TADS / PNVS turrets – Check.

8-22. INTERIOR CHECK – PILOT.

*1. Cockpit door – As desired.
*2. Loose equipment – Secured.
3. Seat – Adjust to design eye position.
*4. Restraint harness – Fasten and adjust.

NOTE

Routing the IHADSS HDU cable under the right arm may cause entanglement during emergency egress.

5. Inertial reel lock – Check.
6. Pedals – Check and adjust.
*7. Parking brake – Set.
8. EDGE LT PNL switch – As desired.
*9. Overhead circuit breakers – As desired.
10. Collective switches – As desired.

CAUTION

Physically confirm that engine chop collar is seated in its latched/centered position and safetied.

11. Auxiliary vent handle – Closed.
12. Utility light – As desired.
13. OAT gauge – Check.
14. ANTI-ICE panel switches – OFF.
*15. EXT LTS, INTR LTS – As desired.
*16. FUEL panel switches – Set as follows:
    a. EXT TK switch – OFF.
    b. TRANS switch – OFF.
    c. CROSSFEED switch – As desired.
    d. ENG 1 switch – ON.
    e. ENG 2 switch – ON.
17. PWR levers – OFF.

18. ENG START switches - OFF.

*19. MASTER IGN switch - Verify on.

20. RTR BK - OFF.

21. ELEC PWR panel - Check switch OFF.

22. STORES JETT select switches - Guard covers down.

*23. ROCKET control panel - Set.

24. ECS control panel - Set as follows:

    a. ENCU - ON.

    b. FAN - NORM

    c. TEMP - As desired.

25. TAIL WHEEL switch - LOCK.

*26. CANOPY JETTISON pin - Remove and stow.

27. FIRE CONTROL panel - Set as follows:

    a. SIGHT SEL switch - STBY.

    b. ACQ SEL switch - OFF.

    c. VID SEL switch - PLT.

    d. ACM switch - OFF.

    e. PNVS switch - OFF.

    f. IHADSS BRSIT switch - OFF.

    g. RKT select switch - OFF.

    h. Gun select switch - OFF.

    i. MSL select switch - OFF.

28. Magnetic compass - Check.

29. BRU - Check.

30. Instrument test panel - As desired.

31. Flight instruments - Check or set as follows:

    a. Airspeed indicator.

    b. Standby attitude indicator - Cage.

    c. VDU - OFF.

    d. RAD ALT - OFF.

    e. Altimeter - Set to field elevation.

    f. Vertical speed indicator.

    g. HSI.

    h. Stabilator position indicator and placard.

32. Clock - Set.

33. Accelerometer - Reset.

34. HARS - OFF

35. EMER HYD switch - OFF.

36. COMM CONT panel switches - As desired.

37. Right console avionics - OFF; set frequencies as desired.

8-23. BEFORE STARTING APU - PILOT.

*1. BATT / EXT PWR switch - BATT position. (EXT if external power is to be utilized, and depress reset button after EXT PWR is applied.)

2. ICS system - Check.

*3. MASTER CAUTION / WARNING panel - Check the following are illuminated:

    a. LOW RPM ROTOR.

    b. ENG 1 OUT.

    c. ENG 2 OUT.

4. MASTER CAUTION / WARNING press to test – Check that all caution/warning and advisory lights illuminate.

5. CAUTION / WARNING panel – Check that the following segments illuminate:

   a. PRI HYD PSI.
   b. UTIL HYD PSI.
   c. OIL PSI ACC PUMP.
   d. OIL PSI NOSE GRBX 1.
   e. OIL PSI MAIN XMSN 1.
   f. OIL PSI MAIN XMSN 2.
   g. OIL PSI NOSE GRBX 2.
   h. OIL PSI ENG 1.
   i. OIL PSI ENG 2.
   j. GEN 1 / (RECT 1 – BAT).
   k. GEN 2 / (RECT 2 – BAT).
   l. FUEL PSI ENG 1.
   m. SHAFT DRIVEN COMP.
   n. MAN STAB (BAT).
   o. FUEL PSI ENG 2.
   p. ENG 1 ANTI-ICE.
   q. ENG 2 ANTI-ICE.
   r. CANOPY (if open).
   s. EXT PWR (EXT PWR).
   t. BLADE ANTI-ICE FAIL.
   u. ADS (EXT PWR).
   v. Charger (EXT PWR).
   w. PNVS (EXT PWR).
   x. TADS (EXT PWR).

6. Fire Detectors – Test as follows:

   a. FIRE TEST DET switch – To position 1. Check that all fire handles and APU fire warning lights in both crew stations illuminate.

   b. FIRE TEST DET switch – To position 2. Check same as in step a. above.

7. INSTRUMENT TEST PANEL – Place the switch in TEST position. Check Engine / Rotor instrument segment lights and digital display (888) illuminate.

8-24. STARTING ENGINES – EXTERNAL PRESSURIZED AIR SOURCE – PILOT.

1. External air source – Connected to helicopter.

2. Pressurized air – Verify available at helicopter.

★3. Engines – Start same as normal (refer to paragraph 8-28).

4. GEN 1 and GEN 2 switches – GEN.

5. EXT PWR / BATT switch – To BATT if external power used for start.

6. External power - Disconnect.

7. External air source – Disconnect.

8. Continue with AFTER STARTING APU – Pilot and CPG (refer to paragraphs 8-26 and 8-36).

*8-25. STARTING APU – PILOT

CAUTION

During cold weather start at temperatures below -18°C (-0°F), place the cold start switch at 95 percent. This prevents engagement of the PTO clutch until the APU has reached 95 percent N_G (operating speed).

1. Fire guard – Posted if available.

2. APU – Start as follows:

   a. APU Control Switch – Set to the run position, pause, START then release.

   b. APU FAIL light – Within 5 seconds of start. Check extinguished.

   c. APU ON light – Check that light illuminates.

3. GEN 1 and GEN 2 switches – GEN.

4. EXT PWR / BATT switch – Set to BATT if external power was used for start.

5. External power – Disconnect. EXT PWR caution light should be off.

*8-26. AFTER STARTING APU – PILOT.

1. PNVS – As required.

2. Standby attitude indicator – Uncage.

3. VDU – Set as desired.

4. RAD ALT – ON.

5. Avionics – As desired.

6. Canopy doors – Close.

CAUTION

Do not execute control sweep if rotor is turning.

7. Control Sweep - Forced Trim, OFF - check cyclic, collective and pedals for freedom of movement. Neutralize cyclic and pedals; place collective full down. Position indicators on base of cyclic are not used for centering. Forced trim - ON and operational.

8. Verify that CPG has entered present position in fire control computer HARS control switch - FAST or NORM as desired.

★ 9. IHADSS Boresight – As required.

★10. FLIR Operational Check – As required.

*8-27. BEFORE STARTING ENGINES – PILOT.

1. SHAFT DRIVEN COMP light – Check off. Verify ECS airflow from crewstation vents.

2. Anti-collision lights – As desired.

*8-28. STARTING ENGINES – PILOT.

1. Area – Clear.

CAUTION

During a rotor brake LOCK start if rotor blades begin to rotate, RTR BK – OFF.

2. RTR BK switch – OFF or LOCK.

■ ★ 3. First engine – Start as follows:

CAUTION

Abort start for any of the following:

- If it becomes apparent that TGT will exceed 867° before N_G idle speed (66% - 68%) is attained.
- If TGT does not increase within 30 seconds after moving power lever to idle.
- If no N_P within 30 seconds, after moving power lever to idle unless rotor locked.
- If positive oil pressure indication does not occur within 30 seconds after moving power lever to idle.
- ENG START light extinguishes prior to 52% N_G.

CAUTION

Abort start procedures are as follows:

(1) PWR lever - OFF.

(2) ENG START switch - IGN OVRD for 30 seconds or until TGT is below 540°C.

a. START switch - START.

b. PWR lever - IDLE after N_G peaks (Nominal 22-28%.), and TGT below 150°C.

c. ENG OIL pressure gage - Monitor.

d. TGT - Monitor

e. N_G - Monitor.

CAUTION

ENG START LIGHT remains illuminated after reaching 66-68% N_G. Do this: ENG START switch (affected engine) - IGN ORIDE, then OFF.

NOTE

A full scale torque spike may occur during start and the MASTER CAUTION light may illuminate along with the FUEL PSI ENG 1 or 2 warning light.

f. Caution warning lights - Check.

NOTE

The second engine may be started with the rotor lock ON as desired or required. Do not advance either PWR lever to FLY until RTR BK switch is OFF.

★ 4. Second engine - Start same as step 3, above.

5. RTR BK switch - OFF.

CAUTION

- Prior to advancing PWR levers, ensure both engines are stabilized (N_P, N_G, torque, and OIL pressure). While advancing power levers to FLY, ensure both engines indicate a torque rise to confirm that the sprag clutches are engaged. If an engine indicates near 0 torque, retard power lever of affected engine to OFF and shut down the aircraft.

- Avoid operations between 60% to 70% NP/NR in excess of one minute. Possible damage might occur due to T/R drive shaft harmonic resonance.

6. PWR levers - FLY. Advance both PWR levers smoothly to FLY and ensure both torques increase simultaneously.

7. N_P and N_R - 100 percent.

8. Caution /warning lights - Check.

9. ANTI-ICE panel ENG INLET switch - As required.

10. APU control switch - OFF.

8-29. DELETED.

*8-30. BEFORE TAXI CHECK.

1. Canopy – Secured.
2. Armament and pylon safety pins – Removed.
3. Chocks and external ICS cords – Removed and disconnected.
4. HARS control switch – Check aligned then advance to OPR.
5. DASE – As desired.
6. HIT check - As required. Perform for first flight of day. Refer to HIT log in aircraft logbook. This step may be performed at any time prior to takeoff.
7. EXT LTS – As desired.
8. PARK BRK – Release.
9. TAIL WHEEL Switch – UNLOCK. Note that green advisory light illuminates.

NOTE

If the advisory light fails to illuminate, taxi forward a short distance while making light pedal inputs.

*8-31. TAXI CHECK.

1. Wheel Brakes – Check.
2. Engine/Rotor Instruments – Check.
3. Flight Instruments – Check.

8-32. DELETED.

*8-33. BEFORE TAKEOFF CHECK.

1. HARS Switch – Verify OPR.
2. Weapons Systems – SAFE.
3. TAIL WHEEL switch – LOCK.
4. Systems check as follows:
   a. FUEL panel switches.
   b. Fuel quantity.
   c. Engine instruments.
   d. Caution / Warning panel.
5. Power Check. The power check is done by comparing indicated torque required to hover with the predicted values from performance charts in Chapter 7.

8-34. INTERIOR CHECK – COPILOT/GUNNER.

*1. Canopy door – As desired.

*2. Loose Equipment – Secured.

3. Seat – Adjusted to design eye position.

*4 Restraint Harness – Fastened and adjust.

NOTE

Routing the IHADSS HDU cable under the right arm may cause entanglement during emergency egress.

5. Inertial reel lock – Check.

6. Pedals – Check and adjust.

7. Collective switches – As desired.

CAUTION

Physically confirm that engine chop collar is seated in its latched/centered position and safetied.

*8. Circuit breakers – As desired.

9. Utility light – As desired.

*10. INTR LTS – As desired.

*11. FUEL panel switches – Set as follows:

  a. ORIDE – PLT.

  b. TRANS – OFF.

  c. BOOST – OFF.

  d. TK SEL – NORM.

12. EMER HYD PWR – OFF, guard down.

13. BAT ORIDE – NRML, guard down.

14. ANTI-ICE panel switches – Set as follows:

  a. TADS GND – OFF.

  b. W/SHLD – PILOT.

15. AUX panel switches – Set as follows:

  a. STBY FAN – OFF.

  b. ADSS – OFF.

16. RECORDER – As desired.

17. MSL panel – Set as follows:

  a. TYPE – LASER.

  b. MODE – STBY.

18. DATA ENTRY keyboard – OFF.

*19. CANOPY JETTISON pin – Remove and stow.

20. FIRE CONTROL panel switches – Set as follows:

  a. RKT select switch – OFF.

  b. GUN select switch – OFF.

  c. MSL select switch – OFF.

  d. LSR select switch – OFF.

  e. SIGHT SELECT switch – STBY.

  f. ACQ SEL switch – FXD.

  g. MUX switch – PRI.

  h. FCC / MUX – ON.

  i. BRSIT – IHADSS and TADS – OFF.

  j. LSR MSL CCM – OFF.

  k. PLT/GND ORIDE – OFF.

  l. LRF/D CCM – OFF.

  m. FC SYM GEN – OFF.

  n. IHADSS – OFF.

  p. TADS – OFF.

21. Engine instrument test panel – As desired.

22. Engine instruments – Check.

23. Flight instruments – Check or set as follows:

  a. Airspeed indicator.

  b. Attitude indicator.

  c. RMI.

  d. Altimeter – Set to field elevation.

  e, Vertical velocity indicator.

  f. Stabilator position indicator and placard.

24. Clock – Set.

25. LT – OFF.

26. COMM CONT panel switches – As desired.

27. Right console avionics – OFF Set to desired frequencies.

28. DOPPLER mode select switch to – OFF.

8-35. BEFORE STARTING APU – COPILOT/ GUNNER.

*1. MASTER CAUTION / WARNING panel – Check that the following are illuminated.

   a. LOW RPM ROTOR.

   b. ENG 1 OUT.

   c. ENG 2 OUT.

2. MASTER CAUTION / WARNING: Press to test – Check that all caution/warning lights illuminate.

3. CAUTION / WARNING panel – Check that the following segments are illuminated.

   a. PRI HYD.

   b. UTIL HYD.

   c. MAN STAB (BAT).

   d. MAIN XMSN 1.

   e. MAIN XMSN 2.

   f. ENG 1.

   g. ENG 2.

   h. ELEC SYS FAIL (BAT).

   i. ENG ANTI-ICE.

   j. ADS (EXT PWR).

   k. TADS (EXT PWR).

4. INSTRUMENT TEST PANEL switch – TEST. Check engine/rotor instrument segment lights and digital display (888) illuminate.

*8-36. AFTER STARTING APU – COPILOT/ GUNNER.

1. Canopy Door – Closed.

2. Avionics – As desired.

3. ADSS – ON.

4. FC SYM GEN – As required.

5. IHADSS – As required.

6. TADS – As required.

★ 7. Fire control system – Enter data/interrogate as desired for:

   a. SP1. (Announce to pilot when present position has been entered.)

   b Waypoint / target data.

   c. Laser codes.

NOTE

Steps 8 thru 14 may be performed in any order.

★ 8. IHADSS boresight – As required.

9. Doppler – Program as desired.

10. TADS – Operational checks.

★11. TADS internal boresight – As required.

★12. TADS outfront boresight – As required.

★13. FLIR – Operational check.

14. Weapons Systems – As desired.

8-37. Taxi.

CAUTION

Excessive cyclic displacement with low power settings may result in droop stop pounding. Excessive forward cyclic displacement with low power settings may result in high strap pack loads.

Initiate taxi by increasing collective to 22 to 24 percent torque and applying slight forward cyclic pressure as required to begin aircraft movement. To maintain forward

8-37. Taxi.

CAUTION

Excessive cyclic displacement with low power settings may result in droop stop pounding Excessive forward cyclic displacement with low power settings may result in high strap pack loads.

Initiate taxi by increasing collective to 20 to 24 percent torque and applying slight forward cyclic pressure as required to begin aircraft movement. To maintain forward movement or taxi speed, do not reduce torque below 20 percent. Control aircraft heading with pedals, and speed with a combination of collective, cyclic and brakes. Deceleration may be controlled by using collective, aft cyclic, and, if required, brakes. Forward cyclic should be limited to the position used to initiate taxi. Use slight lateral cyclic into turns to maintain a level fuselage attitude. Taxiing on soft, rough, or sloping terrain may require the use of more collective than on smooth, level surfaces.

8-38. Maximum Performance.

A takeoff that demands maximum performance from the helicopter is necessary because of various combinations of heavy helicopter loads, restricted performance at high-density altitudes, barriers that must be cleared, and other terrain features. The decision to use the following takeoff techniques must be based on an evaluation of conditions and helicopter performance.

8-39. Level Acceleration/Obstacle Clearance Takeoff.

This procedure is intended for use when a takeoff must be made under conditions when hover capability is limited. Prior to attempting a level acceleration/obstacle clearance takeoff, thorough performance planning must be accomplished to insure that adequate distance is available to clear any obstacles in the takeoff path. To insure that a successful takeoff can be performed within the obstacle clearance distances presented in figure 7-5, all takeoffs must be initiated from 5 feet regardless of hover capability. Once it has been determined that a level acceleration/obstacle clearance takeoff is required and that sufficient distance is available to clear any obstacles, the following procedure shall be used. Align helicopter with the desired takeoff heading and stabilize at 5-foot main wheel height hover (3 to 4 feet indicated radar altitude). Note helicopter hover pitch attitude on the primary attitude indicator. Apply forward cyclic pressure smoothly while simultaneously increasing collective (if additional power is available within helicopter limits) to begin a level acceleration. The maximum available power should be applied before reaching the desired climb airspeed. Additional forward cyclic pressure will be required during the acceleration to overcome the tendency of the aircraft to climb. Approximately 5 KIAS prior to desired climb airspeed, rotate the helicopter to the hover pitch attitude previously noted. Check to insure that maximum available power is applied. Adjust pitch attitude, as necessary, to maintain desired climb airspeed. Once the obstacle has been cleared, adjust helicopter attitude and collective, as required, to establish the desired airspeed and rate of climb.

8-40. Stabilator Operation.

The stabilator is normally operated in the automatic mode. However, the two additional modes available to the pilot can improve helicopter flight characteristics during certain maneuvers. These are:

a. NOE / APPR Mode. Should the pilot desire to improve his over-the-nose visibility for landings or during NOE flight, the NOE/APPR mode may be engaged at any time. An additional benefit is improved forward speed control in NOE flight.

b. Manual Mode. The manual mode of operation is particularly useful for positioning the stabilator to help minimize airframe vibrations when hovering in crosswinds or tailwinds.

8-41. BEFORE LANDING CHECK.

1. Weapons Systems - Safe.
2. TAIL WHEEL switch - LOCK.
3. PARK BRK - As required.

8-42. Slope/Rough Terrain Landing.

For slope landings and all ground operations, avoid using combinations of excessive cyclic and low collective settings. Where minimum collective is used, maintain cyclic near neutral position and avoid abrupt cyclic inputs. If cyclic pitch is required, increase collective slightly to avoid hitting the droop stops and possible rotor-blade-to-fuselage contact.

CAUTION

Care shall be exercised when operating the helicopter on rough terrain. Damage to the underside antennas may result.

NOTE

Prior to landing, external stores may be placed in the ground stow position by placing the rocket select switch on either fire control panel in the GND STOW position.

8-43. AFTER LANDING CHECK.

1. TAIL WHEEL switch - UNLOCK.
2. EXT LTS - As required.
3. Avionics - As required.

8-44. ENGINE SHUTDOWN - PILOT.

NOTE

- To ensure availability of IPAS during engine shutdown, monitor ECS airflow before, during and after APU start up.
- Normal ECS airflow through crew-station vents approximately one minute after APU start indicates IPAS is available during engine shutdown.

1. TAIL WHEEL switch - LOCK.
2. PARK BK - Set.
3. APU control switch - START, then release.
4. Weapons systems - Secure as follows:
   a. SIGHT SEL - STBY.
   b. ACQ SEL - OFF.
   c. VID SEL - PLT.
   d. ACM - OFF.
   e. PNVS - OFF.
   f. WEAPONS SEL - OFF.
   g. MASTER ARM / SAFE - OFF.
5. DASE release switch - Press.
6. STBY ATTD IND - Cage.
7. VDU - OFF.
8. RAD ALT - OFF.
9. HARS - OFF.
10. APU ON, caution light ON.
11. SDC caution light - Extinguished.

CAUTION

- Before moving ENG POWER lever OFF, engine must be cooled for two minutes at an Ng SPEED of 90% or less.
- If an engine is shut down from a high power setting (above 90%) without being cooled for two minutes, and it is necessary to restart the engine, the restart should be accomplished within five minutes after shutdown. If the restart cannot be accomplished within five minutes, the engine shall be allowed to cool for four hours before attempting an engine restart.

12. PWR levers - OFF after engines have cooled for two minutes..
13. FUEL panel switches - Set as follows:
   a. EXT TK switch - OFF.
   b. TRANS switch - OFF.
   c. CROSSFEED switch - NORM.
14. TGT - Monitor.
15. RTR BK switch - BRAKE, below 50% N_R.
16. Avionics - OFF.

17. Light switches - OFF.
18. RTR BK switch - OFF when rotor stops.
19. Confirm with CPG that shutdown is complete (and blanked).
20. GEN switches - OFF.
21. Torque Gages - Note DECU fault codes.
22. APU control switch - OFF.
23. BATT / EXT PWR switch - OFF.
24. CANOPY JETTISON pin - Install.

8-45. ENGINE SHUTDOWN - COPILOT/GUNNER.

1. LT - OFF.
2. SIGHT SELECT - STBY.
3. TADS - OFF.
4. IHADSS - OFF.
5. FC SYM GEN - OFF.
6. Weapons selct - OFF.
7. CPG ARM / SAFE - OFF.
8. PLT / GND ORIDE - OFF.
9. ADSS - OFF.
10. Avionics - OFF.
11. Canopy jettison pin - Install.
12. STBY ATTD IND - Cage.

8-46. BEFORE LEAVING THE HELICOPTER

1. Armament and pylon safety pins - Installed.
2. Conduct walkaround.
3. Complete forms.
4. Secure helicopter - As required.

Section III. INSTRUMENT FLIGHT

8-47. INSTRUMENT FLIGHT.

This helicopter is qualified for operation in instrument meteorological conditions.

8-48. Instrument Flight Procedures.

Refer to FLIP, AR 95-1, FAR Part 91 and FM 1-240.

Section IV. FLIGHT CHARACTERISTICS

8-49. FLIGHT CHARACTERISTICS - GENERAL.

The safe maximum operating airspeed range is described in Chapter 5, Section V.

Section V. ADVERSE ENVIRONMENTAL CONDITIONS

8-50. ADVERSE ENVIRONMENTAL CONDITIONS .

This section informs the crewmembers of the special precautions and procedures to be followed during the various weather and climatic conditions that may be encountered. This material will be additional to that already covered in other chapters regarding the operation of various helicopter systems.

8-51. COLD WEATHER OPERATIONS.

Helicopter operation in cold weather or an arctic environment presents no unusual problems if the flight crew is aware of the various changes that occur in low temperature conditions.

8-52. Cold Weather Preflight.

a. If ice or snow is found in engine inlets and exhaust, remove as much as possible by hand and thaw engine out with hot air before attempting to start. Actuate power levers for freedom of movement before starting main engine.

b. As long as fuel will flow freely from the drains in the tanks, it can be assumed that the system is free of ice. Any indication that flow is restricted is cause for application of heat.

CAUTION

Fuel draining from the affected component after several minutes of heat application does not necessarily indicate that all ice has been melted. Ice may still remain in the unit, and it could be a serious hazard to flight operations. Heat should be applied for a short time after fuel begins to flow from the drain, and the drainage should be checked frequently until it is evident that all water has been removed.

c. If water collected in sumps has frozen (indicated by a lack of flow from drain), apply heat liberally and open drain frequently. Catch all drainage in a clear container and inspect for water globules in the fuel. Continue sampling until fuel is free of water globules.

CAUTION

Ice removal shall never be done by scraping or chipping. Remove ice by applying heat or de-ice liquid (TM 55-1500-204-25/1).

d. In addition to doing a normal preflight in Section II, the rotor head, main rotor blade, tail rotor, and flight controls should be free of all ice and snow. Failure to remove snow and ice accumulations while on the ground can result in serious aerodynamic and structural effects in flight. Check that all fuel tank vents, static ports, pitot tubes, engine inlets, APU inlet, ENCU inlet, and heat exchangers are free of snow and ice; and that tires, landing gear struts, and the hydraulic accumulator are properly serviced.

CAUTION

Due to an elapsed time requirement, it is recommended that the tail rotor teetering bearings warmup procedure be accomplished as the last item of the exterior check during the flight crew preflight inspection. At -31°C (-24°F), the helicopter must be started and the tail rotor must be turning within 5 minutes of teeter bearing warmup. Below -32°C (-25°F), elapsed time is reduced to 2 minutes. At a temperature of -32°C (-25°F) or below, the tail rotor must be cycled by an applied force no greater than 75 lb.

e. The tail rotor teetering bearings are made of elastomeric material which require special warmup procedures prior to certain cold weather flights.

One member of the crew should apply a teetering motion by manually pushing back-and-forth at the tip of the tail rotor blade until the blade has reached its teetering stops. When the blade can be pushed to the stop, the bearing has been sufficiently warmed up. Based on an applied force of 75 lb, the blade must be cycled one time at -32°C (-25°F), five times at -42°C (-44°F), and ten times at -54°C (-65°F).

8-53. Control Exercise.

To eliminate any possibility of droop stop wear should the main rotor blades move through a pitch change angle while resting on the droop stop, the flight crew should observe the following:

At a temperature of -42°C (-44°F) or below, and with a rotor speed of 100 percent N_R, maintain neutral cyclic position for one minute. Then move the cycle forward one inch and hold for one minute. Move the cyclic forward one additional inch and hold for one minute. The total procedure requires three minutes after reaching normal rotor RPM and can be accomplished simultaneously with the engine warmup procedures.

8-54. Engine Operation.

When starting in cold weather below -40°C (-40°F), if light-off does not occur within 10 seconds after placing the power lever to idle, quickly move engine PWR lever for the affected engine to OFF and then to IDLE three times. Then, leave the PWR lever in IDLE. If light-off still does not occur within 40 seconds, abort start and do the following:

1. Engine PWR lever (affected engine) - Hold at LOCKOUT.
2. CROSSFEED switch - AFT.
3. Fuel BOOST switch - ON. Check that ground crew verifies fuel flow from upper drain.
4. Engine PWR lever (affected engine) - OFF.
5. Attempt another start.

8-55. Engine Oil System Characteristics.

a. It is normal for engine oil pressure to be high during initial starts when oil is cold. Run engine at idle until oil pressure is within normal operating limits. Oil pressure should return to the normal range within five minutes. However, time required for warmup will depend on temperature of the engine and lubrication system before start.

b. During starts in extremely cold weather (near -54°C, -65°F), the following oil pressure characteristics are typical:

(1) Oil pressure may remain at zero from 20 to 30 seconds after initiating the start. Abort start if oil pressure does not register within one minute of initiating start.

(2) Once oil pressure begins to indicate on the gauge, it will increase rapidly and go over the 100 psig limit. The pressure will decrease as oil temperature rises and return to within the green band on the gauge. This condition is considered normal. The time for oil pressure to decrease to 100 psig or below will depend on the severity of the ambient temperature, but it should be inside the green band within five minutes of starting the engine.

(3) Oil pressure may increase above the maximum pressure limit of 100 psig if the engine is accelerated above idle while oil temperature is below normal operating range. The pressure will decrease to within the normal operating range as oil temperature increases.

c. The OIL BYP caution light normally goes on when starting an engine with oil below normal operating temperatures because of the relatively high oil viscosity and the amount of contamination in the oil filter. When oil temperature reaches about 38°C (100°F) during engine warmup, the light should go off.

8-56. Engine Warmup.

At temperatures between -17°C and -43°C (1°F and -45°F), warm up engines during engine run-up for three minutes.

8-57. Lightning Strikes.

a. Lightning strikes may result in the loss of the Digital Automatic Stabilization Equipment (DASE), stabilator control, engine electronic control units, and helicopter electrical power. The high voltages passing through the helicopter structure are expected to couple into the helicopter wiring producing secondary effects causing degradation to the mission equipment.

b. If a lightning strike occurs where all helicopter electrical power and engine electrical control units are lost, both engines will go immediately to maximum power output, as if in LOCKOUT. The flight crew shall have to react immediately to retard the power levers to IDLE and enter autorotation. The pilot could then advance the power levers, restoring power, relying solely on rotor and engine sounds and general helicopter handling because of the high probability that all engine instruments would be inoperative.

8-58. GROUND OPERATIONS DURING HIGH WINDS.

WARNING

The maximum wind velocity for rotor start or stops is 45 knots from any direction. Ground operation of the aircraft in winds greater than 45 knots may cause the main rotor blades to contact the fuselage or the aircraft to roll over.

a. If surface winds above 45 knots are anticipated, ground operations should cease and the helicopter should be hangered or moored in accordance with TM 55-1520-238-23. If the helicopter cannot be hangared or moored, and sufficient time exists to shut the A/C down prior to winds exceeding 45 knots, do so. Insure rotor blades are positioned to the 45° point displacement and lock the rotor brake prior to shutting down the APU.

b. If surface winds above 45 knots are inadvertently encountered during ground operations, head aircraft into the wind and maintain 100% NR, lock the tail wheel, set the parking brakes and operate the stabilator in automatic. Adjust the cyclic and collective as necessary to prevent droop stop pounding and keep the helicopter upright.

8-59. TURBULENCE OPERATION.

1. For moderate turbulence, airspeed should be less than 150 knots.

2. For light turbulence, reduce airspeed, if desired, to minimize vibration.

8-60. ICING OPERATION.

1. Preflight/Runup. Prior to flight in icing conditions (visible moisture and below freezing temperatures), special care should be taken to insure that all necessary anti-ice/deice systems are operational. The blade deice system may be checked by holding the BLADE deice switch, on the pilot's anti-ice panel (figure 2-28), to the TEST position. The BLADE advisor light, on the same panel, will illuminate for approximately 3 - 4 seconds. Additionally, the on-command FD/LS may be used to insure proper system operation. The engine inlet and nosegear box anti-ice system may be checked by moving the ENG INLET switch, on the pilot's anti-ice panel, to the ON position. The ENG 1 and ENG 2 ANTI-ICE fail lights on the caution/ warning panel will illuminate and remain on until the fairing heaters reach operating temperature. After approximately 30 to 45 seconds, the ENG 1 and ENG 2 anti-ice fail lights should extinguish and the ENG 1 and ENG 2 advisory lights, on the pilot's anti-ice panel, will illuminate. Prolonged operation of the anti-ice/deice systems while on the ground may result in system damage.

2. Inflight.

a. Anti-ice/deice systems should be activated prior to flight in potential icing conditions (visible moisture and below freezing conditions).

The green BLADE, ENG 1, and ENG 2 advisory lights on the pilot's anti-ice panel should be illuminated. When actual icing conditions are encountered, the ENG ICE light on the caution/warning panel will illuminate and remain on during the icing encounter. The main and tail rotor blades will accumulate ice between heating cycles. This will result in approximately 6 to 10% increase in indicated torque (without collective movement). When the main and tail rotor blades heat and shed ice, there will be a slight momentary increase in airframe vibrations and the indicated torque will drop to approximately the original reading.

b. Particular attention should be devoted to unusual torque rises or persistent airframe vibrations as these may be the first indications of a blade deice system malfunction. Icing rates tend to vary, even over short distances, and may result in continuous changes in the indicated icing rate on the ice rate meter. If continuous large erratic rate needle movements of more than ±0.3 gm/m3 and/or large indicated torque rises are observed, recommend moving the deice mode switch (figure 2-28) to the manual MODERATE position, and depart the icing conditions.

c. Prolonged flight in icing conditions will reduce aircraft maximum range. Fuel consumption will increase approximately 10% (100 to 125 lbs/hr) when the engine anti-ice system is ON.

d. After departing the icing conditions, recommend minimum use of the windshield wipers as shed ice may damage main rotors, tail rotors, and engines.

CHAPTER 9

EMERGENCY PROCEDURES

Section I. HELICOPTER SYSTEMS

9-1. HELICOPTER SYSTEMS.

This section describes the helicopter system emergencies that may reasonably be expected to occur and presents the procedures to be followed. Emergency operation of mission equipment is contained in this chapter, insofar as its use affects safety of flight. Emergency procedures are given in checklist form when applicable. A condensed version of these procedures is contained in the condensed checklist, TM 55-1520-238-CL.

9-2. Immediate-Action Emergency Steps.

NOTE

The urgency of certain emergencies requires immediate and instinctive action by the pilot. The most important single consideration is helicopter control. All procedures are subordinate to this requirement. The MASTER CAUTION segment should be reset after each malfunction to allow systems to respond to subsequent malfunctions. It is always possible that a caution light will unnecessarily illuminate. Whenever possible, check an illuminated light against its associated instrument (FD/LS) to verify that a malfunction has actually occurred. If time permits during a critical emergency, transmit a MAYDAY call.

Those steps that must be performed immediately in an emergency situation are underlined. These steps must be performed without reference to the checklist. When the situation permits, non-underlined steps will be accomplished with use of the checklist.

9-3. Definition of Emergency Terms.

a. The term LAND AS SOON AS POSSIBLE is defined as landing at the nearest suitable landing area (e.g., open field) without delay. (The primary consideration is to ensure the survival of occupants.)

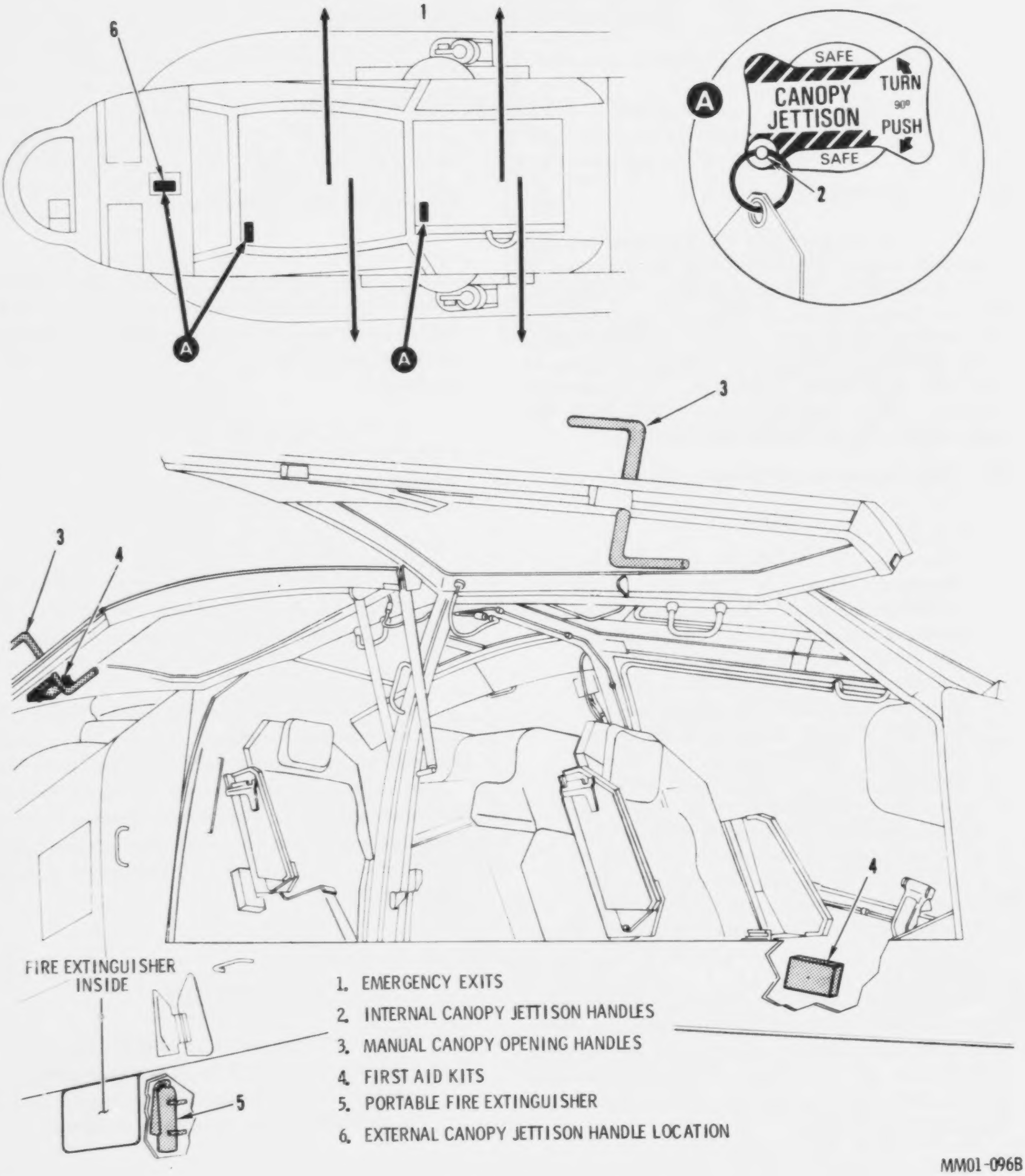
b. The term "LAND AS SOON AS PRACTICABLE" is defined as landing at a suitable landing area. (The primary consideration is the urgency of the emergency.)

c. The term AUTOROTATE is defined as adjusting the flight controls as necessary to establish an autorotational descent and landing.

d. The term "EMER ENG SHUTDOWN" is defined as engine shutdown without delay. Engine shutdown in flight is usually not an immediate-action item unless a fire exists. Before attempting an engine shutdown, identify the affected engine by checking engine-out warning lights, torque meters, TGT indicators, N_G, N_P, and engine oil pressure indicators.

CAUTION

When shutting down an engine that has malfunctioned in flight, it is important to identify the malfunctioning engine to avoid shutting the wrong engine down.


6
1
A
A
A
SAFE
CANOPY
JETTISON
TURN
90°
PUSH
SAFE
2
3
3
4
4
FIRE EXTINGUISHER
INSIDE
5
MM01-096B

1. EMERGENCY EXITS
2. INTERNAL CANOPY JETTISON HANDLES
3. MANUAL CANOPY OPENING HANDLES
4. FIRST AID KITS
5. PORTABLE FIRE EXTINGUISHER
6. EXTERNAL CANOPY JETTISON HANDLE LOCATION

Figure 9-1. Emergency Exits

1. PWR lever (affected engine)-OFF.
2. ENG FUEL switch (affected engine) – OFF.

CAUTION

Monitor TGT after shutdown. If TGT rises above 540°C, or there is evidence of combustion as indicated by a rapid rise in TGT, place the engine START switch in IGN OVRD position and motor engine until TGT decreases below 540°C.

9-4 After-Emergency Action.

After a malfunction of equipment has occurred, appropriate emergency actions have been taken and the helicopter is on the ground, an entry shall be made in the Remarks Section of DA Form 2408-13 describing the malfunction. Ground and flight operations shall be discontinued until corrective action has been taken.

9-5 EMERGINCY EXITS AND EQUIPMENT.

WARNING

- **Rotate the canopy jettison handle to the ARM (90°) position and release. Push the handle to actuate the canopy jettison. Continuing to twist the jettison handle while trying to push may cause the actuator piston to jam and thereby prevent operation of the canopy severance system. If canopy jettison does not occur on the first attempt, insure the handle is in the 90° position, and push again. A push force of 140–150 pounds may be required to overcome the jam and initiate canopy jettison.**
- **In the event that canopy jettison does not occur when the canopy removal system is actuated, the personal survival knife should be used to fracture the canopy panel and permit egress.**

Emergency exits and equipment are shown in figure 9-1.

WARNING

- **If emergency egress is required before the rotor blades have stopped, ensure cyclic remains centered and BATT and TRIM FEEL switches shall be left on to prevent rotors from striking the aircraft or personnel.**
- **In all cases of canopy jettison, remain clear of canopy side panels to avoid high velocity canopy fragments.**

9-6 Emergency Egress.

Emergency egress is accomplished by exiting through the emergency exits. If possible, use the manual canopy opening handles to exit the aircraft. To permit emergency egrees by the pilot and CPG from the helicopter, the transparent portion of the four canopy side panels can be jettisioned by activating a detonation cord. Turning 90 degrees and pushing any of three CANOPY JETTISON handles will initiate canopy side panel jettison. If emergency egress vbecomes necessary, proceed as follows:

1. Helmet visors – Down.
2. CANOPY JETTISON handle – Either crew member turn 90 degrees release, then push.

9-7 Emergency Entrance.

If it becomes necessary to jettison the canopy to gain entrance in case of an emergency.

1. Canopy emergency release door (figure 9-1) – Open.
2. Area around helicopter – Clear of personel at least 50 feet from all canopy side panels.
3. CANOPY JETTISON handle – Turn 90 degrees, release, then push to jettison canopy.

9-8. ENGINE MALFUNCTIONS. Partial or Complete Power Loss.

CAUTION

Prior to movement of either power-control lever, it is imperative that the malfunctioning engine and the corresponding power-control lever be identified.

NOTE

If time permits, during response to emergency situations, the crew must consider transmitting a "MAYDAY" call, setting transponder to emergency, jettisoning external stores, and locking shoulder harness.

9-9. Flight Characteristics.

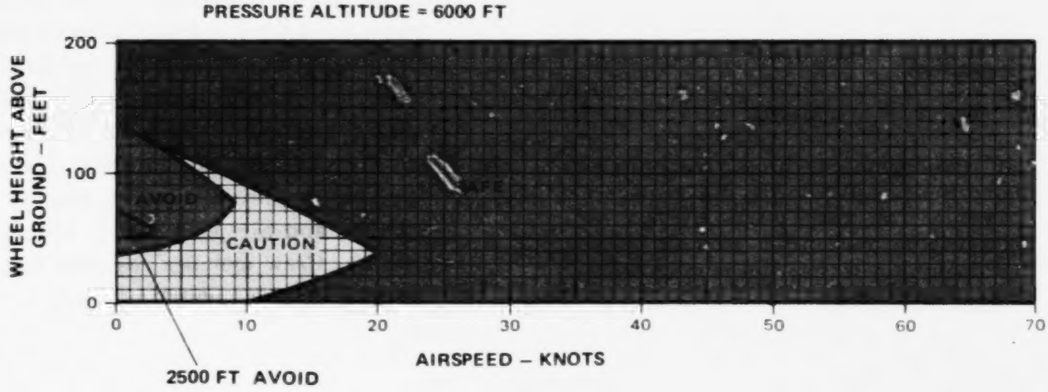
The flight characteristics and the required crew member control response after a dual engine failure are similar to those during a normal power-on descent. Full control of the helicopter can be maintained during autorotational descent. When one engine has failed, the helicopter can often maintain altitude and airspeed until a suitable landing site can be selected. Whether or not this is possible becomes a function of such combined variables as aircraft weight, density altitude, and altitude and airspeed at the time of the engine failure. Crew member response time and control technique may be additional factors.

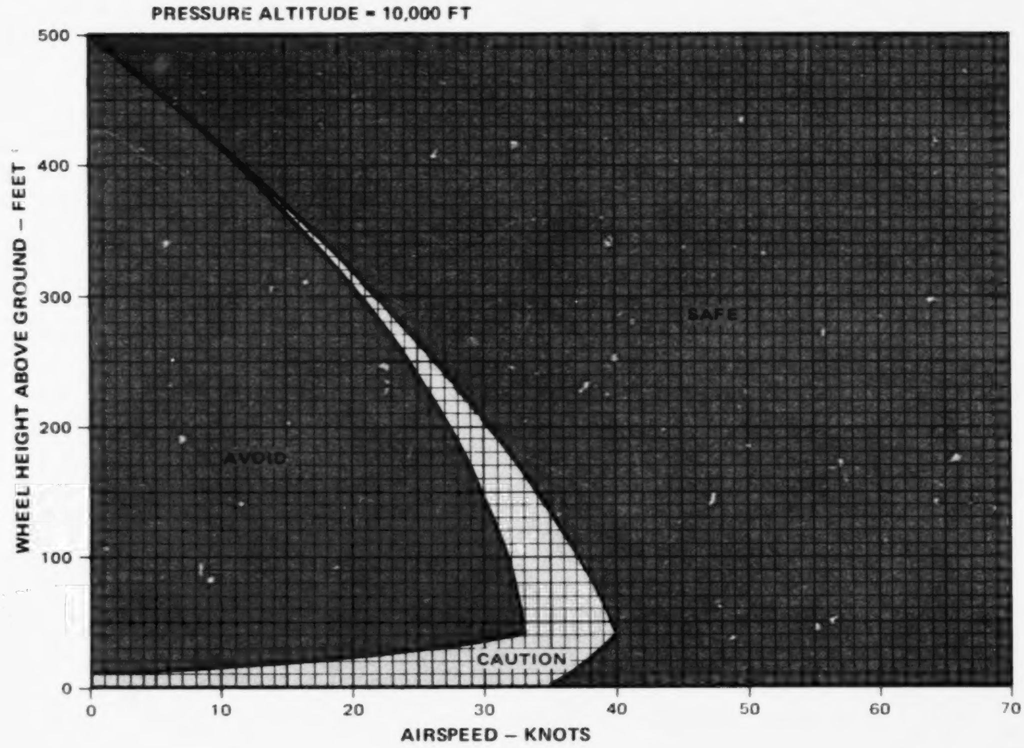
■ □ ■
G Y R

HEIGHT-VELOCITY
SINGLE-ENGINE FAILURE

STD TEMP, ZERO WIND
GROSS WEIGHT = 14,660 LB OR LESS

NOTE: THERE IS NO AVOID AREA AT SEA LEVEL


PRESSURE ALTITUDE = 6000 FT


PRESSURE ALTITUDE = 10,000 FT

■ □ ■
G Y R
MM01-183-1B

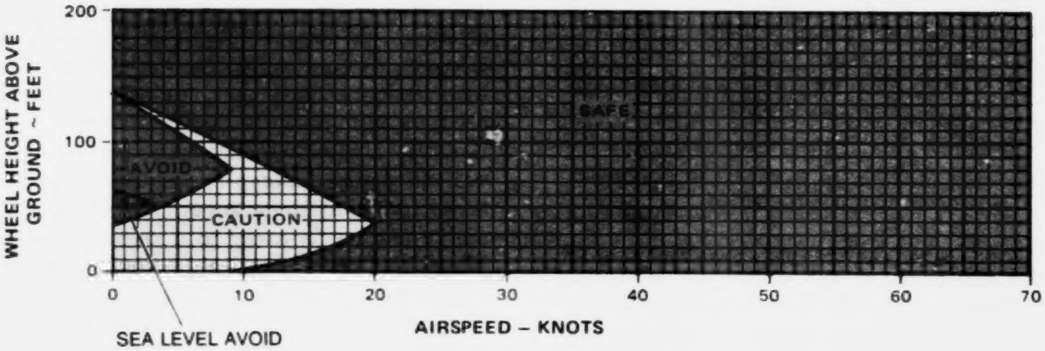
Figure 9-2. Height Velocity Plots (Sheet 1 of 2)

■ □ ■
G Y R

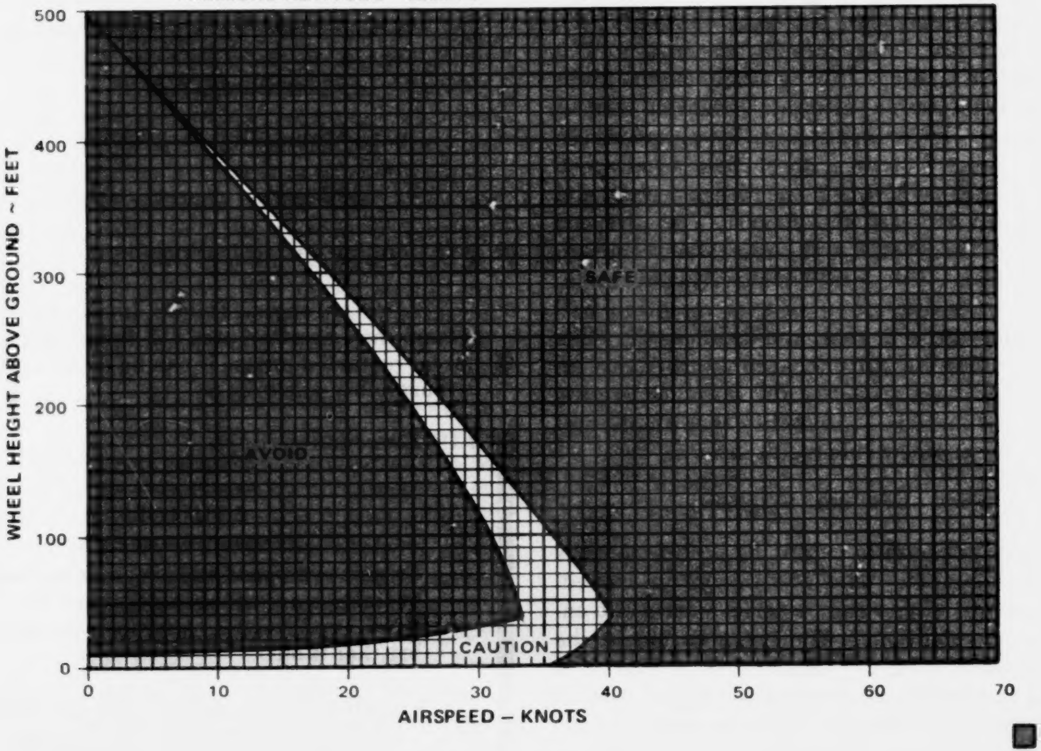
HEIGHT-VELOCITY
SINGLE-ENGINE FAILURE

STD TEMP, ZERO WIND
GROSS WEIGHT = 17,650 LB

PRESSURE ALTITUDE = 2500 FT



PRESSURE ALTITUDE = 6000 FT



■ □ ■
G Y R
MM01-183-2B

Figure 9-2. Height Velocity Plots (Sheet 2 of 2)

9-10. Engine Failure: General.

The various conditions under which an engine may fail prevent a standard procedure for all cases. A thorough knowledge of both emergency procedures and flight characteristics will enable the pilot to respond correctly and automatically in an emergency. The engine instruments often provide ample warning of an impending failure by deviating from normal behavior. Engine failure is normally indicated by a rapid drop in N_G, N_P, torque, TGT, and oil pressure of the affected engine. The ENGINE OUT warning lights will illuminate and an audio signal will be heard through both headsets. Engines may fail only partially, and the degree of failure (amount of power loss) is another factor affecting crew member response.

When an engine fails completely, the engine PWR lever and FUEL panel switch of the failed engine should be turned OFF. The reduction required in collective after engine failure will vary with altitude and airspeed at the time of failure. For example, the collective should not be reduced when an engine fails while the helicopter is hovering below 15 feet. During cruise flight, when altitude and airspeed permit a significant reduction in collective pitch, N_R can be restored to 100 percent before landing. During single-engine flight or during autorotation, airspeed should be kept at the optimum. Optimum autorotation airspeeds are shown in figure 9-3. In autorotation, as airspeed increases above 70-80 KIAS, the rate of descent and glide distance increase significantly. As airspeed decreases below 64 KIAS, the rate of descent will increase and glide distance will decrease. Autorotation during an out-of-trim condition will increase the rate of descent and decrease the glide distance. Engine failure accompanied by an explosion or loud noise would indicate engine damage, and there is a possibility that an attempt to restart the engine would result in a fire.

9-11. Single-Engine Failure: General.

Proper response to an engine failure depends on various factors: density altitude, airspeed, aircraft weight, single-engine performance, and environmental conditions. The green region in the height velocity diagram (figure 9-2) defines the airspeed and wheel-height combinations at various gross weight and density altitude combinations that will permit a safe landing in event of an engine failure. Crew member recognition and subsequent action are essential and should be based on the following general guidelines: At low density altitude and low airspeed, it may be necessary to lower the collective only enough to maintain N_R at a value less than 100 percent. At higher density altitude, however, the collective may be lowered significantly to increase N_R to 100 percent. When hovering in ground effect, the collective should be used only as required to cushion the landing, and the primary consideration is in maintaining a level attitude. In forward flight at low altitude (as in takeoff), when a single-engine capability to maintain altitude does not exist, a decelerating attitude will initially be required to prepare for landing. Conversely, if airspeed is low and altitude sufficient, the helicopter should be placed in an accelerating attitude to gain sufficient airspeed for single-engine fly-away to a selected landing site. When the power available during single-engine operation is marginal or less, consideration should be given to jettisoning the external wing stores.

9-12. Single-Engine Failure Low Altitude/Low Airspeed and Cruise.

a. Continued flight is not possible.

Land as soon as possible.

b. Continued flight is possible.

Land as soon as practicable.

9-13. Engine Restart During Flight.

After an engine failure in flight, an engine restart may be attempted. A failed engine should not be restarted unless it can be determined that it is reasonably safe to do so.

9.14. Emergency Start.

CAUTION

Engine overspeed and overtemperature protection are not provided when the ENG 1 or ENG 2 (as appropriate) circuit breaker is out.

The following emergency start may be attempted if the hot start preventer will not permit a normal engine start and starting is necessary because of a tactical emergency situation.

1. ENG 1 or ENG 2 (engine to be started) circuit breaker - Out
2. Engine - Start, using normal starting procedure.
3. ENG 1 or ENG 2 circuit breaker - In, prior to advancing PWR lever to FLY.

9-15. Dual-Engine Failure: General.

WARNING

In the event of an inadvertent activation of the engine chop collar, initial indications from N_P and N_R could be interpreted as a dual engine failure. Indications of engine chop collar activation are the engine chop light illuminates and engine idle indications on the N_G, TGT and N_P. There is "no" illumination of the engine out lights on the master Caution and Warning panel.

a. If both engines fail, immediate action is required to make a safe autorotative descent. The altitude and airspeed at which a two-engine failure occurs will dictate the action to be taken. After the failure, main rotor rpm will decay rapidly and the aircraft will yaw to the left. Unless a two-engine failure occurs near the ground, it is mandatory that autorotation be established immediately. During cruise at airspeeds to Vne, reduce collective immediately to regain N_R and then adjust as required to maintain rpm. The cyclic should be adjusted as necessary to attain and maintain airspeed in the optimum range (figure 9-3). An airspeed between 64 and 98 KIAS should be maintained except for high-altitude high-gross weight conditions where the maximum allowable autorotation airspeed should be maintained if it is less than 64 KIAS. A landing area must be selected immediately after both engines fail, and control inputs must be made to fly to the intended site. Throughout the descent, adjust collective as necessary to maintain N_R within normal range. At high gross weights, the rotor may tend to overspeed and the collective must be used to maintain the desired rotor rpm. Figure 5-1 shows the rotor limitations. N_R should be maintained at or slightly above 100 percent to allow ample rpm before touchdown, and heading maintained by pedals.

b. Main rotor rpm will increase momentarily when the cyclic is moved aft with no change in collective pitch setting. An autorotative rpm of approximately 100 percent provides for a good rate of descent. N_R above 100 percent may result in a higher than desired rate of descent. At 100 to 125 feet AGL, use aft cyclic to decelerate. This reduces airspeed and rate of descent and causes an increase in N_R. The degree of increase depends upon the amount and rate of deceleration. An increase in N_R can be desirable in that more inertial energy in the rotor system will be available to cushion the landing. Ground contact should be made with some forward speed. If a rough landing area is selected, a more pronounced deceleration is necessary and touchdown speed should approach zero. It is possible that during the autorotative approach, the situation may require additional deceleration. In that case, it is necessary to assume a landing attitude at a higher altitude than normal. Should both engines fail at low airspeed, initial collective reduction may vary widely. The objective is to reduce collective as necessary to maintain N_R within normal range. In some instances at low altitude or low airspeed, settling may be so rapid that little can be done to avoid a hard-impact landing. In that case, it is critical to maintain a level landing attitude. Cushion the landing with remaining collective as helicopter settles to the ground.

9-16. Dual Engine Failure Low Altitude/Low Airspeed and Cruise.

1. Autorotate.
2. Chop Collar – Reset.

9-17. HIGH RPM ROTOR (WARNING LIGHT ON) N_P FAILED HIGH.

1. Collective – Adjust to maintain N_R within limits.

If condition persists:

2. PWR lever (affected engine) – Retard to equalize torque on both engines.
3. Land as soon as practicable.

AUTOROTATIONAL DESCENT

POWER OFF

N_R = 100%

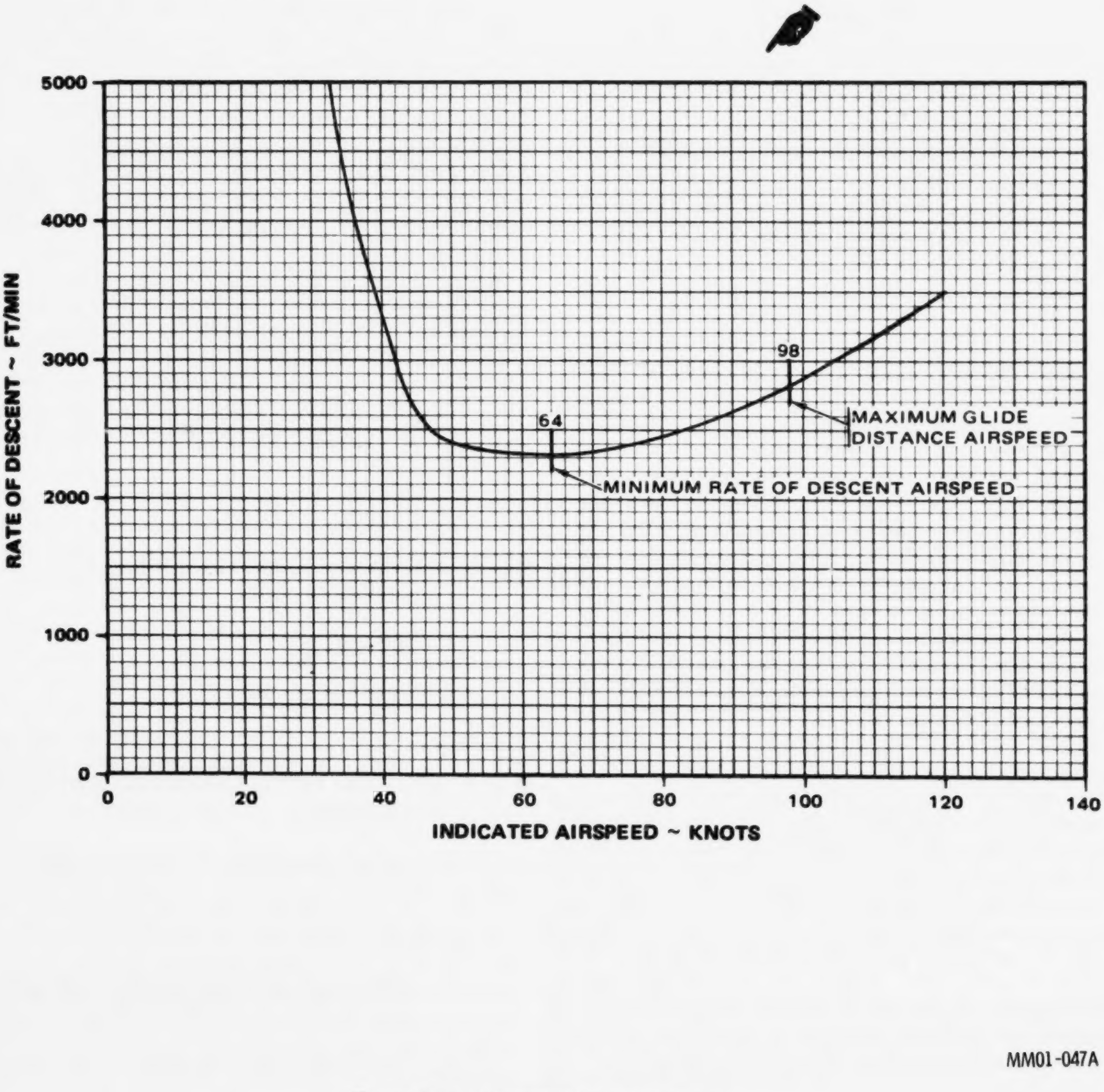


Figure 9-3. Autorotative Glide Chart

9-18. LOW RPM ROTOR (WARNING LIGHT ON) N_P FAILED LOW.

1. Collective – Adjust to maintain N_R within limits.

If condition persists:

2. PWR lever (affected engine) Lockout – then retard to equalize torque output of both engines.

NOTE

Advancing the PWR lever of the engine with low torque and TGT to LOCKOUT disables the signal from the electrical control unit (ECU). The engine must be controlled manually to ensure that it does not exceed operating limits.

If manual control is not possible:

3. PWR lever (affected engine) – IDLE.
4. Land as soon as practicable.

9-19. Engine Compressor Stall.

An engine compressor stall is normally recognized by a noticeable bang or popping noise and possible aircraft yaw. These responses are normally accompanied by a rapid increase in TGT and fluctuations in N_G, TORQUE, and Np readings for the affected engine. In the event of a compressor stall;

1. Collective – Reduce.

   If condition persists:

2. PWR lever (affected engine) – Reduce. (TGT should decrease.)
3. PWR lever (affected engine) – FLY. If TGT has decreased and there is no further evidence of a stall continue flight.

   If stall condition recurs:

4. PWR lever (affected engine) – IDLE.
5. Land as soon as practicable.

9.20. ROTORS, TRANSMISSIONS, AND DRIVE SYSTEMS.

9-21. Tail Rotor Malfunctions.

WARNING

Pilot situational awareness and correct analysis of the aircraft's condition and operational environment are critical in the successful accomplishment of these procedures. The low inertia rotor system, coupled with high rates of descent during vertical autorotations, may not provide the pilot with adequate reaction time and cushioning pitch. Activation of the chop collar or reduction of the power levels prior to reduction of the collective will result in a rapid decay of rotor RPM. Successful completion of an out-of-ground-effect hovering autorotation is doubtful.

These procedures represent a best estimate of helicopter reactions and crew procedures. The most critical consideration in responding to any tail rotor malfunction is that the crew member correctly interprets the nature and extent of the problem. Tail wheel should be locked during all landings.

9-22. Loss of Tail Rotor Thrust – General.

CAUTION

If engine chop is used to minimize main rotor torque, increasing collective pitch without first retarding PWR levers to idle may cause an uncommanded yaw.

Loss of tail rotor thrust occurs when there is a break in the drive system; for example, a severed drive shaft. The nose of the helicopter will turn to the right. If the helicopter is in forward flight, there will be a right roll of the fuselage along the longitudinal axis, and the nose of the helicopter may pitch downward. Normal pilot input to compensate for the right roll will produce a left side-slip. This downward pitch will be more pronounced if a tail rotor component has separated from the helicopter. In some cases, depending on the severity of the right rotation, powered flight to a suitable landing area can be accomplished by maintaining or increasing airspeed. The degree of sideslip and the amount of roll may be varied by changing airspeed and by varying collective pitch. Neither, however, can be completely eliminated.

9-23. Loss of Tail Rotor Thrust in Cruise Flight.

WARNING

If the airspeed is allowed to approach effective translational lift, the sideslip angle may become quite severe and helicopter control may be lost.

a. Continued Flight Possible.

At cruise airspeeds, it may be possible that level flight at some stabilized yaw angle can be maintained. The degree of sideslip will depend on the airspeed and power required to maintain flight. Some left cyclic should be used to stop the slow right turn induced by the loss of thrust. Care should be taken to avoid slowing the helicopter. The airspeed indicator may not provide useful information once the sideslip is established, but true airspeed, yaw angle, engine torque, and rate of climb or descent should provide the cues necessary to maintain flight. If yaw angle becomes excessive, reduce power and lower the nose to regain adequate airspeed. A minimum of 80 knots during a shallow approach to a roll–on landing should be maintained until approximately 10 to 20 feet above the touchdown point. Begin a gradual deceleration to arrive at approximately 5 to 10 feet above touchdown as the yaw angle begins to increase (to the right). At this point, retard the power levers as necessary to align the helicopter fuselage with the landing direction. Care should be taken to use minimum collective pitch to cushion the landing during touchdown.

After touchdown, the wheel brakes should be used to maintain heading and the collective should be lowered to minimize torque.

1. Airspeed – 80 KIAS minimum (until 10 to 20 feet above touchdown).

2. PWR levers – Reduce as necessary (5 to 10 feet above touchdown).

b. Continued Flight Not Possible

If powered flight at an airspeed sufficient to maintain helicopter control is not possible, enter autorotation, and CHOP Collar – CHOP (altitude and airspeed permitting). In autorotation, the sideslip and roll angles can be significantly reduced by maintaining a sufficiently high airspeed to allow the fuselage to streamline. A roll-on landing during touchdown will minimize the required pitch application and should be used if terrain permits. Before touchdown, time permitting, the engine power levers should be retarded to OFF.

1. Autorotate.

2. CHOP Collar – Chop.

3. PWR Levers – Off (prior to touchdown).

9-24. Loss of Tail Rotor Thrust At Low Airspeed/ Hover.

CAUTION

Continuous right rotation during descent and touchdown can be expected.

Loss of tail rotor thrust at slow speed may result in extreme yaw angles and uncontrolled rotation to the right. Immediate collective pitch reduction should be initiated to reduce the yaw and begin a controlled rate of descent. If the helicopter is high enough above the ground, an attempt should be made to increase airspeed to streamline the helicopter. This may permit continued flight with a stabilized and manageable yaw angle. If this increase in airspeed does reduce yaw angle, proceed as outlined in paragraph 9-23, Loss of Tail Rotor Thrust in Cruise Flight (Continued Flight Possible). If the aircraft cannot be accelerated into forward flight, initiate a power-on descent. Collective should be adjusted so that an acceptable compromise between rate of turn and rate of descent is maintained. At approximately 5 to 10 feet above touchdown, perform a hovering autorotation by CHOP Collar – CHOP or PWR levers – OFF.

1. Collective – Reduce.

2. PWR Levers – OFF (5 to 10 feet above touchdown).

9-25. Tail Rotor Fixed Pitch Malfunction.

A fixed pitch failure may be evidenced by slow, intermittent, or no response to pedal input or no pedal movement. A left or right yaw may be apparent.

a. If a failure occurs during in-ground-effect hover, reaction may vary from adjusting collective and power levers during a left rotation to activating the chop collar to stop a right rotation. In any case, the primary concern should be to land the aircraft with as little yaw rate as possible.

(1) If the aircraft has an uncontrolled turn to the left, a reduction in the power levers coordinated with an increase in collective may slow or stop the rotation so that a controlled power on descent to landing can be accomplished.

(2) If the aircraft is not turning, a slight reduction in collective pitch will begin a descent. During the descent, a slight rotation to the left may be present; increasing collective just prior to touchdown should stop the rotation.

(3) If the aircraft has an uncontrolled turn to the right, reduce collective to begin descent. At approximately 5 to 10 feet AGL perform a hovering autorotation by CHOP Collar-CHOP or PWR Levers - OFF.

b. Out-Of-Ground Effect.

(1) If little or no right rotation or if left rotation is experienced and control can be maintained, the aircraft should be accelerated into forward flight and a roll-on landing accomplished. Proceed as in loss of tail rotor thrust in cruise flight.

(2) If the aircraft cannot be accelerated into forward flight, initiate a power-on descent. Collective should be adjusted so that an acceptable compromise between rate of turn and rate of descent is maintained. At approximately 5 to 10 feet above touchdown, perform a hovering autorotation by CHOP Collar-CHOP or PWR Levers - Off.

9-26. Main Transmission Input Drive Clutch Failure.

An input drive clutch malfunction is most likely to occur during engine start or when an engine power lever is advanced. Indications may include: erratic torque indication on the affected engine, or a complete loss of torque indication on the affected engine, and/or Np of the affected engine exceeding Nr. If the failure is a sudden disengagement, the torque of the opposite engine will double as it attempts to carry the load. A sudden high torque input drive clutch engagement may cause severe engine and/or drive train damage. A sudden engagement is indicated by a loud noise and/or a sudden increase in engine torque. Should an input drive clutch malfunction occur, perform the following:

a. In flight.

(1) PWR lever (affected engine) - IDLE

(2) If Np (affected engine) does not drop below Nr, leave PWR lever at idle.

(3) Once Np (affected engine) is below Nr: EMER ENG SHUTDOWN (affected engine only).

(4) Land as soon as practicable.

b. On ground.

WARNING

Do not shut down both engines simultaneously.

(1) EMER ENG SHUTDOWN (affected engine only).

(2) Check Ng is less than 10% (affected engine).

(3) Perform normal aircraft shutdown.

9-27. FIRES.

The safety of the helicopter occupants is the primary consideration when a fire occurs. On the ground, it is essential that the engine (s), and APU be shut down, the crew evacuated, and fire fighting begin immediately. If time permits, a "MAYDAY" radio call should be made before electrical power if OFF to expedite assistance from fire fighting equipment and personnel. If airborne, the most important single action that can be taken by the crew is to land the helicopter. Consideration should be given to jettisoning external stores prior to landing.

NOTE

- The PRI bottle should be selected first; in the event of a malfunction or failure to extinguish the fire, select RES.
- If the APU is running, accomplish an APU shutdown prior to evacuating the aircraft.

9-28. Engine/Fuselage Fire on Ground

If ENG FIRE PULL handle illuminates or if fire is observed:

1. PWR levers - OFF
2. Illuminated ENG FIRE PULL handle - Pull if applicable.
3. FIRE BTL switch - Activate if applicable.

9-29. APU FIRE Handle Illumination in Flight.

An APU FIRE handle illumination in flight may be an indication of a fire in the transmission area. If the fire is in the transmission area pulling the APU fire handle, and discharging the fire bottles may have little or no effect on the fire.

(1) APU FIRE PULL handle – PULL.

(2) Land as soon as possible.

9-30. APU Compartment Fire.

If fire is observed in APU compartment or if APU FIRE PULL handle on pilot right console illuminates:

1. APU FIRE PULL handle – Pull.
2. FIRE BTL switch – Activate.

9-31. Engine Fire in Flight.

1. PWR lever (affected engine) – OFF.
2. Illuminated ENG FIRE PULL handle – Pull.
3. FIRE BTL switch – Activate.
4. Land as soon as possible.

9-32. Electrical Fire in Flight.

Prior to shutting off all electrical power, the pilot must consider the equipment that is essential to a particular flight environment which will be affected; e.g., flight instruments, flight controls, etc. With electrical power off, engine anti-ice is automatically on. If an immediate landing cannot be made, the defective circuit may be isolated by selectively turning off electrical equipment and/or pulling circuit breakers.

1. GEN switches – OFF.
2. Land as soon as possible.

9-33. Smoke and Fume Elimination.

1. Airspeed – Slow to 20 KIAS maximum.
2. Canopy door (affected crew position) – Open to intermediate position.
3. Land as soon as possible.

9-34. ELECTRICAL SYSTEM MALFUNCTIONS.

9-35. GEN 1 and GEN 2 CAUTION LIGHT ON.

NOTE

In the event both generators are lost, turn off all unnecessary equipment on the emergency bus to conserve battery power. Battery power, assuming a 90-percent charge, is normally sufficient for 12 minutes emergency bus operation. When the battery heater is inoperative/disconected and operating at temperatures below minus 30 degrees celsius (minus 22 degrees F), power may only be available for one minute of emergency operation.

Land as soon as practicable.

9-36. HYDRAULIC SYSTEM MALFUNCTIONS.

9-37. PRI HYD PSI and UTIL HYD PSI Light On.

1. EMER HYD switch – On.
2. Land as soon as possible.

WARNING

- Immediate emergency action must follow failure of both hydraulic systems. Any hesitation could result in loss of helicopter control. With emergency hydraulic power in use, flight control inputs must be kept to an absolute minimum. Hydraulic power available is limited to a maximum of one 180 degree turn and four full collective applications. The amount of control movement may be reduced to zero depending on the severity and location of the hydraulic fluid loss within the utility system. Once the EMER HYD switch is turned on, it must remain on.

9-38. PRI HYD PSI and OIL UTIL HYD LIGHT ON.

In the event of a PRI HYD PSI failure and LOW UTIL HYD condition, hydraulic power to the T/R servo may be lost. This may require a landing IAW T/R FIXED PITCH MALFUNCTION.

Land as soon as possible.

9-39. LANDING AND DITCHING.

9-40. Emergency Landing in Wooded Areas (Power Off).

1. Autorotate.
2. Collective – Adjust to maximum before main rotor contacts tree branches.

9-41. Ditching (Power On).

The decision to ditch the helicopter shall be made by the pilot when an emergency makes further flight unsafe.

1. Approach to hover.
2. Canopies – Jettison.
3. Pilot shoulder harness – Lock.
4. CPG – Exit helicopter.
5. Hover downwind a safe distance.
6. PWR levers – OFF.
7. Perform hovering autorotation – Apply full collective to decay RPM as helicopter settles.
8. Cyclic – Position in direction of roll.
9. Exit when main rotor has stopped.

9-42. Ditching (Power Off).

If autorotational landing over water becomes necessary.

1. Autorotate – Apply full collective to decay rotor RPM as helicopter settles.
2. Canopies – Jettison.
3. Cyclic – Position in direction of roll.
4. Exit when main rotor has stopped.

9-43. FLIGHT CONTROL MALFUNCTIONS.

a. Failure of components within the flight control system may be indicated through varying degrees of feedback, binding, resistance, sloppiness or abnormal control response. These conditions should not be mistaken for the malfunction of the DASE.

b. Imminent failure of main rotor components may be indicated by a sudden increase in main rotor vibration and/or unusual noise. Severe changes in lift characteristics and/or balance condition can occur due to blade strikes, skin separation, shift or loss of balance weights or other material. Malfunctions may result in severe main-rotor flapping. If the main-rotor system malfunctions, proceed as follows:

WARNING

Danger exists that the main-rotor system could collapse or separate from the aircraft after landing. A decision must be made whether occupant egress occurs before or after the rotor has stopped.

c. During ground operations any abnormal control inputs required to maintain desired fuselage attitude may be indicative of a problem. If this condition occurs, complete a normal engine shutdown.

1. Land as soon as possible.
2. EMER ENG(S) SHUTDOWN after landing.

9-44. Stabilator Automatic Mode Failure.

1. STAB reset button – Press.

   If automatic mode is not restored:

2. Use manual stabilator .
3. Land as soon as practicable.

9-45. Stabilator Auto / Manual Mode Failure.

1. Airspeed – Use placard limits. If both crew station indicators are inoperative (90 knots maximum):
2. Land as soon as practicable.

9-46. DASE MALFUNCTION.

DASE malfunctions may manifest themselves as uncommanded control inputs, which may cause unusual rotor disc movement, or aircraft attitude/heading changes.

1. ASE release SW – depress.
2. SAS re-engage unaffected axes.

9-47. SYMBOL GENERATOR FAILURE.

Failure of the symbol generator will result in the loss of video to the VDU and VCR. Both the PLT and CPG HDU will automatically revert to PNVS FLIR-2 (PNVS video with no symbology). The ORT, HOD or HDD, as selected, will automatically revert to TADS FLIR-2 (TADS FLIR video). If the CPG VID SEL switch is positioned to TADS, the LOS reticle and IAT gates (if operational) symbology from the TEU will be displayed. If the CPG VID SEL is positioned to PNVS, these symbols will not be displayed. The AND display will continue to operate normally. The pilot may continue flight in a degraded mode without flight or weapons symbology. The CPG may continue weapons engagement in a degraded mode without range information.

9-48. TADS ELECTRONIC UNIT (TEU) FAILURE.

Complete failure of the TEU will cause the CPG's displays to blank. ORT, HOD/HDD, AND, and HDU. The pilot may be limited to ±75 degrees in azimuth on the PNVS and the message PNVS DIRECT will be displayed in the HAD sight status section.

9-49. FLIR COOLER FAILURES.

Failure of the PNVS or TADS FLIR cooler normally occurs during FLIR cool-down prior to flight. However, the cooler may fail in flight. Cooler failures are indicated by a loss of resolution on the FLIR. Resolution loss occurs gradually initially, and becomes more rapid as detector temperatures increase until resolution is lost completely. In the event of a PNVS cooler failure, proceed as indicated in PNVS failure emergency.

Section II. MISSION EQUIPMENT

9-50. MISSION EQUIPMENT FAILURE.

9-51. Wing Stores Jettison.

1. Airspeed – 120 KIAS maximum.
2. Selected STORES JETT switches – Activate.

OR

3. ST JETT – Press.

9-52. ENCU MALFUNCTION.

1. ENCU switch – OFF.
2. ECS switch – STBY FAN if desired.
3. Emergency crewstation ventilator door – Open if desired.

9-53. PNVS/IHADSS.

WARNING

If night or simulated night NOE, reaction to the following malfunctions must be immediate. Exit the NOE environment immediately.

NOTE

During rolling maneuvers, a phenomena known as DC restoration may degrade the PNVS imagery. Generally, this image degradation will worsen as the bank angle is increased. To reduce the adverse effects of DC restoration, the pilot should reduce the amount of sky visible within the PNVS field of view by viewing the terrain below the horizon.

9-54. PNVS Failure.

Pilot NVS select switch – TADS. Switchover to TADS WFOV FLIR image should occur in about 3 seconds. TADS slew rates noticeably slower in azimuth than PNVS. Some gain and level adjustment is usually necessary for optimum image.

9-55. Pilot IHADSS/HDU Failure.

Pilot

1. Establish visual flight.
2. VDU control switch – PLT.
3. ACQ SEL – NVS FXD.

OR

CPG

1. CPG SIGHT SEL switch – NVS.
2. PLT / GND ORIDE switch – PLT / GND ORIDE.
3. NVS select switch – PNVS or TADS.
4. CPG assume helicopter control.

9-56. ENGINE ALTERNATOR MALFUNCTION.

The engine alternator has three windings, providing power for engine ignition, aircraft Ng speed indication, and electrical control system operation. A failure of the ignition winding would result in loss of electrical power to the ignition circuitry which would be detected by inability to start the engine. A failure of the winding providing Ng speed indication signal would not affect actual engine operation; however, the pilot would have no Ng indication. A failure of the winding providing electrical power to the engine ECU is the most severe and requires immediate action by the pilot. The immediate indication to the pilot may be the affected engine accelerating to maximum power. There will also be a loss of Np and torque indication. If this failure is due to a complete loss of the alternator, then no Ng indication will be present either. The engine TGT will still be indicating because it is not acted upon by the ECU; however, TGT limiting will no longer be available. Np overspeed protection will still be present because aircraft power is supplied for that function. If an alternator failure is suspected and the affected engine accelerates to maximum power, proceed as in HIGH RPM (WARNING LIGHT ON) Np FAILED HIGH.

Section III. CAUTION/WARNING LIGHT EMERGENCY PROCEDURES

WORD SEGMENT	CORRECTIVE ACTION
MASTER CAUTION WARNING PANEL:	
MASTER CAUTION	Check Master /Caution Warning and Caution - panels for other lights. If no other light is flashing land as soon as possible.
LOW RPM ROTOR	See Low RPM Rotor Warning Light On/Np Failed Low.
FIRE APU	See APU Compartment Fire.
ENGINE 1 OUT	See Single-Engine Failure Low Altitude/Low Airspeed and Cruise.
ENGINE CHOP	Chop collar – Reset.
ENGINE 2 OUT	See Single-Engine Failure Low Altitude/Low Airspeed and Cruise.

NOTE

ENG 1 and 2 out. See Dual-Engine Failure Low Altitude/Low Airspeed and Cruise.

WORD SEGMENT	CORRECTIVE ACTION
HIGH RPM ROTOR	See High RPM (Rotor Light On) Np Failed High.
BUCS FAIL	BUCS circuit breaker – Out.
CAUTION/WARNING PANELS:	
FUEL LOW FWD	Information/system status.
EXT EMP	Information/system status.
FUEL XFR	Information/system status.
PRI HYD PSI	Land as soon as possible.
UTIL HYD PSI	Land as soon as possible.
MAN STAB	With audio – Refer to emergency procedures. Light only – Information/system status.
BUCS ON	Information/system status.
ADS	Information/system status.
FUEL LOW AFT	Information/system status.
BOOST PUMP ON	Information/system status.
OIL LOW PRI HYD	Land as soon as practicable.
OIL LOW UTIL HYD	Land as soon as practicable.
PRI HYD and UTIL HYD PSI	Refer to emergency procedures.

NOTE

OIL low PRI ,and UTIL HYD – Land as soon as possible.

WORD SEGMENT	CORRECTIVE ACTION
OIL PSI ACC PUMP	Land as soon as practicable.
ASE	Land as soon as practicable.
REFUEL VALVE OPEN	Information/system status.
CHIPS NOSE GRBX 1	Power lever – Idle when conditions permit. Land as soon as practicable.

WORD SEGMENT	CORRECTIVE ACTION
OIL BYP PRI HYD	Land as soon as practicable.
OIL BYP UTIL HYD	Land as soon as practicable.
CHIPS NOSE GRBX 2	Power lever – Idle when conditions permit. Land as soon as practicable.
CHIPS ENG 1	Power lever – Idle when conditions permit. Land as soon as practicable.
OIL PSI NOSE GRBX 1	Power lever – Idle when conditions permit. Land as soon as practicable.
OIL PSI MAIN XMSN 1	Land as soon as practicable.
OIL PSI MAIN XMSN 2	Land as soon as practicable.

NOTE

OIL PSI MAIN XMSN 1 and 2 – Land as soon as possible.

OIL PSI NOSE GRBX 2	Power lever – Idle when conditions permit. Land as soon as practicable.
CHIPS ENG 2	Power lever – Idle when conditions permit. Land as soon as practicable.
OIL PSI ENG 1	EMER ENG SHUTDOWN when conditions permit. Land as soon as practicable.
OIL HOT NOSE GRBX 1	Power lever – Idle when conditions permit. Land as soon as practicable.
OIL HOT MAIN XMSN 1	Land as soon as practicable.
OIL HOT MAIN XMSN 2	Land as soon as practicable.

NOTE

OIL HOT MAIN XMSN 1 and 2 – Land as soon as possible.

OIL HOT NOSE GRBX 2	Power lever – Idle when conditions permit. Land as soon as practicable.
OIL PSI ENG 2	EMER ENG SHUTDOWN when conditions permit. Land as soon as practicable.
OIL BYP ENG 1	Power lever – Idle when conditions permit. Land as soon as practicable.
GEN 1 and GEN 2	GEN switches 1/2 - OFF/RESET - GEN. If power not restored GEN switches--OFF. Land as soon as practicable.
RECT 1 and RECT 2	Land as soon as practicable.
GEN 1	GEN switch--OFF/RESET--GEN. If power is not restored – GEN switch--OFF/RESET.
RECT 1	Information/system status.
GEN 2	GEN switch--OFF/RESET--GEN. If power is not restored GEN switch--OFF/RESET.
RECT 2	Information/system status.
OIL BYP ENG 2	Power lever – Idle when conditions permit. Land as soon as practicable.
FUEL BYP ENG 1	Power lever – Idle when conditions permit. Land as soon as practicable.
HOT RECT 1	Circuit breaker – Out.
CHIPS MAIN XMSN	Land as soon as possible.
TEMP INT	Land as soon as practicable.
TEMP TR	Land as soon as practicable.
HOT RECT 2	Circuit breaker – Out.
FUEL BYP ENG 2	Power lever – Idle when conditions permit. Land as soon as practicable.

WORD SEGMENT	CORRECTIVE ACTION
FUEL PSI ENG 1	Land as soon as practicable.
PRI MUX	Information/system status.
RDR JAM	Information/system status.
SHAFT DRIVEN COMP	Land as soon as possible.
VIB GRBX	Land as soon as possible.
HOT BAT	BAT switch--OFF. Land as soon as practicable.
CHARGER	Information/system status.
FUEL PSI ENG 2	Land as soon as practicable.
FUEL PSI ENG 1 AND ENG 2	Fuel crossfeed switch--AFT TK – Fuel boost switch – ON. Land as soon as possible.
GUN	Information/system status.
ROCKET	Information/system status.
IR JAM	Information/system status.
PNVS	See PNVS failure.
BLADE ANTI-ICE FAIL	Information/system status.
ENG ICE	Anti-ice panel switches – As desired.
RTR BK	RTR BK switch – OFF. Land as soon as possible.
CANOPY	Information/system status.
EXT PWR	Information/system status.
MISSILE	Information/system status.
IFF	Information/system status.
ECS	Information/system status.
TADS	Information/system status.
CANOPY ANTI-ICE FAIL	Information/system status.
ENG 1 ANTI-ICE	Information/system status.
ENG 2 ANTI-ICE	Information/system status.
APU ON	Information/system status.
APU FAIL	Information/system status.
— (SPARE)	Land as soon as possible.
CPG PANEL ONLY	
PRI HYD	Coordinate actions with pilot.
UTIL HYD	Coordinate actions with pilot.
MAIN XMSN 1	Coordinate actions with pilot.
MAIN XMSN 2	Coordinate actions with pilot.
ENG 1	Coordinate actions with pilot.
ENG 2	Coordinate actions with pilot.
ELEC SYS FAIL	Coordinate actions with pilot.
ENG ANTI-ICE	Coordinate actions with pilot.
VOICE CIPHER	Information/system status.

NOTE

Illumination of a light that is information/system status shows condition of Systems Components. Mission accomplishment may be degraded. Mission requirements will dictate further actions.

NOTE

For conditions which will cause the lights to illuminate, see Table 2-4/2-5/2-6.

APPENDIX A

REFERENCES

AR 70-50	Designating and Naming Military Aircraft, Rockets, and Guided Missiles
AR 95-1	Flight Regulations
AR 95-13	Safety Procedures for Operation and Movement of Army Aircraft on the Ground
AR 95-3	General Provisions, Training, Standardization, and Resource Management
AR 385-40	Accident Reporting and Records
FAR Part 91	Federal Air Regulation, General Operating and Flight Rules
FLIP	Flight Information Publication
FM 1-240	Instrument Flying and Navigation for Army Aviators
FM 1-230	Meteorology for Army Aviators
TB MED 501	Noise and Conservation of Hearing
TM 55-9150-200-25	Engine and Transmission Oils, Fuels, and Additives for Army Aircraft
TM 55-1500-342-23	Army Aviation Maintenance Engineering Manual: Weight and Balance
TM 55-1520-238-CL	Operator's and Crew Member's Checklist, Army Model AH-64A Helicopters
TM 55-6600-200-20	Markings of Instruments and Interpretation of Markings
TM 750-244-1-5	Procedures for the Destruction of Aircraft and Associated Equipment to Prevent Enemy Use
FM 1-202	Environmental Flight
FM 1-203	Fundamentals of Flight

TM 9-1095-206-13&P	Operator's Aviation Unit Maintenance and Aviation Intermediate Maintenance Manual Including Repair Parts and Special Tools Lists for Dispenser, General Purpose, Aircraft: M130
AR 385-63	Policies and Procedures for Firing Ammunition for Training, Target Practice and Combat
TB MED 524	Occupational and Environmental Health: Control of Hazards from Laser Radiation
TM 11-5895-1199-12	Operator's and Organizational Maintenance for Mark-XII IFF System
TM 11-5810-262-OP	Operating Procedures for Communications Security Equipment TSEC/KY-58 in Aircraft Operations
TM 11-5841-281-12	Operator's and Organizational Maintenance Manual: Doppler Navigation Set
TM 11-5841-283-12	Aviation Unit Maintenance Manual for Radar Signal Detecting Set
TM 11-5865-200-12	Operator's and Aviation Unit Maintenance Manual Aviation Unit Maintenance (AVUM) Countermeasures Sets
TM 3-4240-312-12&P	Operator's and Unit Maintenance Manual Including Repair Parts and Special Tools List for Mask, Chemical - Biological: Aircraft, M43

APPENDIX B

ABBREVIATIONS AND TERMS

A

•	Used as a decimal
°C	Degrees Celsius
°F	Degrees Fahrenheit
ΔF	Change in frontal area
ΔQ	Torque change for ΔF of 5 sq. ft.

A	Ampere
AH	Attack helicopter
AC, ac	Alternating current
A/C	Aircraft
ACC	Accumulator
ACM	Auto control module
ACQ	Acquire
ACT, ACTN	Action
ADF	Automatic direction finder
ADS	Air data sensor
AGL	Above ground level
ALT	Altimeter
AM	Amplitude modulation
AMMO	Ammunition
AMP	Ampere
AND	Alphanumeric display
ANT	Antenna
ANTI COL	Anticollision
APU	Auxiliary power unit
ARCS	Aerial rocket control system
ATTD	Attitude
AUTO	Automatic
AUX	Auxiliary
AVAIL	Available
AWS	Area weapon system
AZ	Azimuth

B

BAT (or BATT)	Battery
BITE	Built-in test equipment
BRK	Brake
BL	Blade (rotor)
BNK	Bunker
BOT	Beginning of tape

Appendix B – Abbreviations and Terms (cont)

BRG	Bearing
BRK	Brake
BRSIT	Boresite
BRT	Bright (switch position)
BRU	Boresight reticle unit
BST	Boost
BTL	Bottle (fire extinguisher)
BUCS (or BUC)	Backup control system
BYP	Bypass

C

C	Celsius
CAN	Canopy
CAS	Command augmentation system
CAUT	Caution
CBHK	Captive boresight harmonization kit
CDU	Computer display unit
CG, cg	Center of gravity
CHK	Check
CHRGR	Charger (battery)
CK	Check
CKT	Circuit
CL	Clear
CM, cm	Centimeter
CNTST	Contrast
COL	Collision
COLL, coll	Collective
COMM	Communication
COMM CONT	Communication control
COMP	Compressor, compass
CONT	Continuous, control
CPG	Copilot/gunner
CRS	Course
CRT	Cathode ray tube
CSL	Console
CW	Continuous wave

D

DASE	Digital automatic stabilization equipment
DC, dc	Direct current
DECR	Decrease
DECU	Digital Electronic Control Unit
DEK	Data entry keyboard
DEST	Destination
DET	Detector (fire detector)
D/F	Direction Finding
DG	Directional gyro
DIA, dia	Diameter
DIR	Directional
DISP, DSP	Display
DIST	Distance

Appendix B – Abbreviations and Terms (cont)

E

ECS	Environmental control system
ECU	Electrical control unit (for engine)
EDGE LT PNL	Edge light panel (switch)
EL	Elevation
ELEC, ELECT	Electrical, electric
ELEV	Elevation
ELEX	Electronics
EMER	Emergency
EMERG	Emergency
EN, ENT	Enter, entry
ENCU	Environmental control unit
END	Endurance
ENG	Engine
ENG CUT	Engine cut
ENG INST	Engine instrument (lighting)
ENS	Environment control system
ESS	Essential
EXT	Extend, external, extinguisher
EXT LTS	External lights
EXT-RET	Extend, retract
EXT TK	External tank, auxiliary fuel tank

F

FAB	Forward avionics bay
FAT	Free air temperature
FCC (AC)	Fire control computer
FCS	Fire control system
FD/LS	Fault detection and location system
FFAR	Folding-fin aerial rocket
FIRE BTL	Fire bottle
FLIR	Forward looking infrared
FLT	Flight
FLT INST	Flight instrument (lighting)
FLTR	Filter
FM	Frequency modulation
FOC	Focus
FOD	Foreign object damage
FORM LT	Formation light
FOV	Field of view
FRL	Fuselage reference line
FT, ft	Foot, feet
FT/MIN	Feet per minute
FTR	Filter
FWD	Forward
FXD	Fixed

Appendix B – Abbreviations and Terms (cont)

G

G, g	Gravity
GEN	Generator
GND	Ground
GPM, gpm	Gallons per minute
GRB, GRBX	Gearbox
GRWT	Gross weight
GS	Ground speed, gray scale
GSE	Ground support equipment
GUN MTR	Gun motor
GW	Gross weight

H

H	Home
HAD	High action display
HARS	Heading and attitude reference system (set)
HDG	Heading, heading set
HE	High explosive
HF	High frequency, Hellfire
HIGE	Hover in ground effect
HIT	Health indicator test
HMD	Helmet-mounted display
HMMS	Hellfire module missile system
HMS	Helmet-mounted sight
HMU	Hydromechanical unit
HOGE	Hover out of ground effect
HOV	Hover
HSI	Horizontal situation indicator
HSP	Hot start preventor
HT	Heat, heater height
HTR	Heater
HYD	Hydraulic
Hz	Hertz

I

IAS	Indicated airspeed
ICS	Intercommunication system, internal communication system
IDENT	Identification
IFF	Identification Friend or Foe (transponder)
IFR	Instrument flight rules
IGE	In ground effect
IGN	Ignition
IHADSS	Integrated helmet and display sight system
IMC	Instrument meteorological conditions
INBD	Inboard
INCR	Increase
IND	Indicator
INST, INSTR	Instrument

Appendix B – Abbreviations and Terms (cont)

INTMD	Intermediate
INTR LTS	Interior lights
IP, I/P	Identification of position
IPAS	Integrated Pressurized Air System
IR	Infrared
IRIS	Infrared imaging seeker
IR JMR	Infrared jammer
IRP	Intermediate rated power

J

JETT	Jettison
JMR	Jammer

K

KG, kg	Kilogram
KIAS	Knots, indicated airspeed
KTAS	Knots, true airspeed
KVA, kva	Kilovolt ampere
KYBD	Keyboard

L

L	Left
LAT	Latitude
LB	Pound
LB/HR	Pounds per hour
LCHR	Launcher
LCF	Low cycle fatigue
LDG	Landing
LDG LT	Landing light
LDNS	Lightweight Doppler navigation system
LDS	Load demand spindle
LF	Low frequency
LH	Lefthand
LOAL	Lock on after launch
LOBL	Lock on before launch
LONG	Longitude
LOS	Line of sight
LRF/D	Laser range finder designator
LRU	Line replaceable unit
LSR	Laser
LT	Light, laser tracker
LTS	Lights
LVDT	Linear variable differential transducer (position sensor)
LVR	Lever

Appendix B – Abbreviations and Terms (cont)

M

M, m	Meter
MAL	Malfunction
MAN	Manual
MAX	Maximum
MEM	Memory
MHz	Megahertz
mHz	Millihertz
MIC	Microphone
MIKE	Microphone
MIN	Minimum, minutes
MLG	Main landing gear
MM, mm	Millimeter
MON	Monitor
MRTU	Multiplex remote terminal unit
M/R	Main rotor
MSL	Missile, mean sea level
MTR	Motor
MUX	Multiplexer, multiplex
M230E1	30-mm gun

N

NAV	Navigation
NAV LT	Navigation light
NG, N_G	Engine gas generator speed
NM	Nautical mile
NOE	Nap of the earth
NP, N_p	Engine power turbine speed
NR, N_R	Main rotor speed
NRML, NORM	Normal
NVS	Night vision system

O

OAT	Outside air temperature
ODV	Overspeed and drain valve
OGE	Out of ground effect
OPR	Operator
ORT	Optical relay tube
OTBD	Outboard
Overtemp	Overtemperature
ORIDE	Override
OVSP	Overspeed

Appendix B – Abbreviations and Terms (cont)

P

para	Paragraph
PAS	Pressurized air system, power available spindle
PCT	Percent
PEN	Penetration
PLT	Pilot
PNL	Panel
PNVS	Pilots night vision system
PP	Present position
ppm	Pounds per minute
PRES, PRESS	Pressure
PRI	Primary
PSI, psi	Pounds per square inch
PSID	Pounds per square inch delta
PSIG, psig	Pounds-force per square inch gage
PTO	Power takeoff
PWR	Power
PYL	Pylon

Q

Q	Torque
QTY	Quantity

R

R	Right, red
RAD	Radio, radar
RAD ALT	Radar altimeter
R/C	Rate of climb
RCDR	Recorder
RCVR	Receiver
RDR	Radar
RNDS	Rounds
REC	Recorder
RECT	Rectifier, transformer-rectifier
REF	Reference
REL	Release
REM	Remote
RES	Reserve
RET, RETR	Retract
RETRAN	Retransmit
RF	Radio frequency
RH	Righthand
RHE	Remote Hellfire electronics
RIPL	Ripple

Appendix B – Abbreviations and Terms (cont)

RKT	Rocket
RMI	Radio magnetic indicator
RNG	Range
RPM, rpm	Revolutions per minute
RTR	Rotor
RTR BK	Rotor brake
RTR BL	Rotor blade
RTSS	Radio transmitter select system
	S
SAS	Stability augmentation subsystem
SCAS	Stability and command augmentation system
SCL	Scale
SDC	Shaft driven compressor
SDD	Selectable digital display
SEC	Secondary
SEL	Select
SEU	Sight electronics unit
SG	Symbol generator
SHP	Shaft horsepower
SKR	Seeker
SL	Sea level
SN	Serial number
SPAD(S)	Shear-pin-actuated decoupler (system)
SPH	Spheroid
SQ	Super quick
SQ FT, sq ft	Square foot, square feet
SCHLT	Searchlight
SRCH PWR	Searchlight power
ST	Stores
STA, STN	Station
STAB	Stabilizer, stabilator
STBY	Standby (fan)
STBY ATT	Standby attitude
STD	Standard
STR	Storage, store
STRS	Stores
SYM GEN	Symbology generator
SYS	System
	T
T1, T2	Test patterns 1 and 2
T4.5	Five-probe harness measuring gas temperature at power turbine inlet
T700	The T700 engine
TADS	Target acquisition and designation system

Appendix B – Abbreviations and Terms (cont)

TAS	True airspeed
TBD	To be determined
TBS	To be supplied
TEMP	Temperature
TGT	Turbine gas temperature, target
TK	Tank, track
TK SEL	Tank select switch
TKE	Tracking angle error
TLG	Tail landing gear
TNK	Tank
T/R	Transmitter-receiver, transmit-receive, transformer-rectifier
TRANS	Transfer
TST	Test
	U
UHF	Ultra-high frequency
UTL	Utility
UTM	Universal transverse mercator
	V
V, v	Volt
VAC, vac	Volts alternating current
VAR	Variation, variable
VDC, vdc	Volts direct current
VDU	Video display unit
VHF	Very high frequency
VID	Video
VID RCDR	Video recorder
V_{ne}, VNE	Velocity, never exceed (airspeed limit)
VOL	Volume
VROC	Vertical rate of climb
VSI	Vertical speed indicator
VSWR	Voltage standing wave ratio
	W
W	Watt
WAS	Weapon action select
WE	Weight empty
WHL	Wheel
WHT	White (switch position)
WRP	Wiper (windshield)
WSHLD	Windshield
WSHLD WPR	Windshield wiper
WSPS	Wire Strike Protection System

Appendix B – Abbreviations and Terms (cont)

X

XFEED	Crossfeed
XFER	Transfer
XMSN	Transmission
XTK	Crosstrack

Y

Y	Yellow

ALPHABETICAL INDEX

Subject . . . Paragraph

A

Abbreviations and Terms, Appendix B, . . . 1-5
AC Power Supply System . . . 2-98
Accelerometer . . . 2-116
Accumulator, Utility . . . 2-66
Adverse Environmental Conditions . . . 8-50
Aerial Rocket Control Subsystem Panel (ARCS) . . . 4-12
Aerial Rocket Control and Delivery System-Inflight Procedures . . . 4-55
After Landing Check . . . 8-43
After Starting APU-Copilot/Gunner . . . 8-36
After Starting APU-Pilot . . . 8-26
After-Emergency Action . . . 9-4
Air Data Sensor Subsystem (ADSS) . . . 4-3
Air Induction, Engine . . . 2-24
Air Source Receptacles, External . . . 2-71
Air Source, Ground . . . 2-133
Air Temperature Indicator, Free (Outside) . . . 2-115
Air, No. 1 Engine Bleed . . . 2-70
Aircraft Designation . . . 1-11
Airspeed Indicators . . . 2-122
Airspeed Operating Limits . . . 5-19
Airspeed Operating Limits Chart . . . 5-20
Airspeed and Cruise, Dual Engine Failure Low Altitude/Low . . . 9-16
Airspeed and Cruise, Single-Engine Failure Low Altitude/Low . . . 9-12
Airspeed/Hover, Loss of Tail Rotor Thrust at Low . . . 9-24
Allowable Loading . . . 6-30
Alpha/Numeric Display (AND) . . . 4-43
Alteration of CBHK Values . . . 5-25
Alternator Malfunction, Engine . . . 9-56
Altimeter Set AN/APN-209(V) . . . 3-47
Altimeters (AAU-31/A), Barometric . . . 2-110
Altitude/Low Airspeed and Cruise, Dual Engine Failure Low . . . 9-16
Altitude/Low Airspeed and Cruise, Single-Engine Failure Low . . . 9-12
Ammunition (30mm) . . . 6-26
AN/ALQ-136 (Complete Provisions Only), Radar Jammer Set . . . 4-26
AN/APN-209(V), Altimeter Set . . . 3-47
AN/APR-39 V-1, Radar Signal Detector Set . . . 4-20
AN/APX-100(V) 1 (IFF), Transponder . . . 3-41
AN/ARC-164, Operational Procedures Radio Set . . . 3-17
AN/ARC-186(V), Radio Set . . . 3-8
AN/ARC-186, Operating Procedures, Radio Set . . . 3-12
AN/ARN-89, Direction Finder Set . . . 3-22
AN/ASN-137 Controls Displays and Functions . . . 3-38.1
AN/ASN-137 Displays . . . 3-38.3
AN/ASN-137 Modes of Operation . . . 3-38.2
AN/ASQ-170, Target Acquisition Designation Sight (TADS) . . . 4-37
Annunciators, Crew Station Instruments, Indicators, . . . 2-11
Annunciators, Engine Caution/Warning . . . 2-39
Antenna (ARC-164(V)) . . . 3-14
Antenna (IFF) . . . 3-42
Antenna, DNS . . . 3-27
Antennas . . . 3-9
Antennas (AN/APN-209(V)) . . . 3-48
Antennas (AN/ARN-89) . . . 3-23
Anti-Icing System, Engine and Engine Inlet . . . 2-25
Anti-Icing and De-icing . . . 2-94
Appendix A, References . . . 1-4
Appendix B, Abbreviations and Terms . . . 1-5
APU Compartment Fire . . . 9-30
APU Fire Handle Illumination in Flight . . 9-29
APU-Copilot/Gunner, After Starting . . . 8-36
APU-Copilot/Gunner, Before Starting . . . 8-35
APU-Pilot, After Starting . . . 8-26
APU-Pilot, Before Starting . . . 8-23
APU-Pilot, Starting . . . 8-25
ARC-164(V), Receiver-Transmitter Radio, RT-1167C . . . 3-13
Areas, Danger . . . 2-7
Armament Configurations, Authorized . . . 4-44
Armament Description . . . 4-45
Army Aviation Safety Program . . . 1-7
Army Material to Prevent Enemy Use, Destruction of . . . 1-8

ALPHABETICAL INDEX (cont)

Subject Paragraph

Arrangement, General ... 2-4
Assemblies, Damper ... 2-91
Attitude Indicators ... 2-123
Attitude Reference System (HARS), 3-52
Audio Warning System, Headset ... 2-124
Authorized Armament Configurations ... 4-44
Auto/Manual Mode Failure, Stabilator ... 9-45
Automatic Mode Failure, Stabilator ... 9-44
Automatic Stabilization Equipment, Digital ... 2-57
Auxiliary Fuel Tank ... 2-46
Auxiliary Fuel and Tanks, Wing ... 6-17
Auxiliary Power Fuel Supply ... 2-58
Auxiliary Power Unit (APU) ... 2-104
Auxiliary Power Unit (APU) Operating Limits ... 5-16
Auxiliary Power Unit (APU) Servicing ... 2-130
Auxiliary Power Unit Fire Detection, 2-19
Aviation Life Support Equipment (ALSE) ... 8-2
Aviation Safety Program, Army ... 1-7
Avionics Equipment Configuration ... 3-2
Avionics Power Supply ... 3-3
Avionics, Helicopter Mission ... 4-2
Avionics-General, Mission ... 4-1

B

Backup Bus Controller (BBC) ... 4-4
Backup Mode, AN/ASN-128 ... 3-32
Barometric Altimeters (AAU-31/A) ... 2-110
Basic Weight and Balance Record, DD FORM 365-3, Chart C - ... 6-8
Battery ... 2-102
Battery Override Switch, CPG ... 2-103
Before Exterior Check ... 8-9
Before Landing Check ... 8-41
Before Leaving the Helicopter ... 8-46
Before Starting APU-Copilot/Gunner ... 8-35
Before Starting APU-Pilot ... 8-23
Before Starting Engines-Pilot ... 8-27
Before Takeoff Check ... 8-33
Before Taxi Check ... 8-30
Blades, Main Rotor ... 2-92
Bleed Air, No. 1 Engine ... 2-70
Blower - General Information, CBR ... 2-20.2
Blower, CPG CBR ... 2-20.4
Blower, Pilot CBR ... 2-20.3
Blower, Survivability Equipment - CBR ... 2-20.1
Boresight, TADS ... 4-51
Boresight-CPG, IHADSS ... 4-50
Boresight-Pilot, IHADSS ... 4-48

Subject Paragraph

Brake, Rotor ... 2-79
Brakes, Landing Gear ... 2-10
Briefings, Crew ... 8-4
Bus Controller (BBC), Backup ... 4-4
Bus Subsystem (MUX), Multiplex ... 4-6

C

Canopy Panels, Windshield and ... 2-12
Canopy and Windshield Cleaning ... 2-139
Cargo Loading ... 6-28
Cargo, Extra ... 6-29
Cartridges, Chaff ... 6-27
Caution Light Indicators, Intermediate Gearbox ... 2-83
Caution Light Indicators, Tail Rotor Gearbox ... 2-85
Caution Light ON, GEN 1 AND GEN 2 ... 9-35
Caution Light Provisions, Engine Nose Gearbox ... 2-75
Caution Lights, Main Transmission ... 2-78
Caution and Warning Panels, Pilot and CPG Master ... 2-118
Caution/Warning Annunciators, Engine ... 2-39
Caution/Warning Lights, Fuel System ... 2-45
Caution/Warning Panels, Pilot and CPG ... 2-119
CBHK Data Validation ... 4-39.1
CBHK Values, Alteration of ... 5-25
CBR Blower - General Information ... 2-20.2
CBR Blower, CPG ... 2-20.4
CBR Blower, Pilot ... 2-20.3
CBR Blower, Survivability Equipment - Helicopter ... 2-20.1
Center Fuselage (Area 2), Right Side-Lower ... 8-12
Center Fuselage (Area 5), Right Side-Rear ... 8-15
Center Fuselage (Area 8), Left Side-Bar ... 8-18
Center Fuselage and Nose (Area 11), Left Side-Lower ... 8-21
Center of Gravity Limits ... 5-17
Center of Gravity Limits Chart ... 6-31
Center of Gravity Management ... 6-13
Chaff Cartridges ... 6-27
Chapter 7 (Performance Data) Index ... 7-2
Characteristics, Engine Oil System ... 8-55
Characteristics, Flight ... 9-9
Characteristics-General, Flight ... 8-49
Chart C - Basic Weight and Balance Record, DD FORM 365-3 ... 6-8

ALPHABETICAL INDEX (cont)

Subject	Paragraph
Chart, Airspeed Operating Limits	5-20
Chart, Center of Gravity Limits	6-31
Check, After Landing	8-43
Check, Before Exterior	8-9
Check, Before Landing	8-41
Check, Before Takeoff	8-33
Check, Before Taxi	8-30
Check, Exterior	8-10
Check, Preflight	8-8
Check, Taxi	8-31
Check-Copilot/Gunner, Interior	8-34
Check-Pilot, Interior	8-22
Checklist	8-7
Checks-CPG, TADS Operational	4-49
Chip Detector, Engine	2-31
Class, Helicopter	6-3
Cleaning, Canopy and Windshield	2-139
Clocks	2-111
Clutch Failure, Main Transmission Input Drive	9-26
Cold Weather Operations	8-51
Cold Weather Preflight	8-52
Collective Sticks	2-53
Color Code, Instrument Marking	5-6
Command Tests, FDLS	4-39
Compartment Fire, APU	9-30
Compartments	2-8
Compartments and Stations, Helicopter	6-4
Compartments, Equipment Stowage	2-13
Compass, Standby Magnetic	2-114
Compressor Stall, Engine	9-19
Compressor, Shaft Driven	2-69
Computer (FCC), Fire Control	4-5
Computer Kit-1A/TSEC, Transponder	3-46
Conditions, Adverse Environmental	8-50
Configuration, Avionics Equipment	3-2
Configuration, Wing Stores	5-24
Configurations, Authorized Armament	4-44
Consoles, Copilot/Gunner Instrument Panel	2-16
Consoles, Pilot Instrument Panel	2-15
Control (Management) Panel, Pilot Fuel	2-42
Control Exercise	8-53
Control Malfunctions, Flight	9-43
Control Panel (Complete Provisions Only), Radar/Infrared Countermeasures Subsystem	4-25
Control Panel, Copilot/Gunner Missile	4-32
Control Panels, Copilot/Gunner (CPG)	4-29
Control Panels, Pilot	4-11
Control Pedals, Directional	2-54
Control Servos, Flight	2-56
Control Subsystem Panel (ARCS), Aerial Rocket	4-12
Control System, Engine	2-35
Control System, Engine Fuel	2-26
Control System, Environmental	2-96
Control System, Flight	2-51
Control and Delivery System-Inflight Procedures, Aerial Rocket	4-55
Controller (BBC), Backup Bus	4-4
Controls	2-2
Controls Displays and Functions, AN/ASN-137	3-38.1
Controls Indicators and Functions (HSI)	3-40
Controls Indicators and Functions (AN/APN-209(V))	3-49
Controls and Displays, Optical Relay Tube (ORT)	4-36
Controls and Functions (C-10410(V) 3/ARC-C-11746(V) 4/ARC)	3-6
Controls and Functions (AN/ARC-186(V))	3-10
Controls and Functions (TSEC/KY-58)	3-19
Controls and Functions (AN/ARN-89)	3-24
Controls and Functions (RT-1296/APX-100(V))	3-43
Controls and Functions (RT-1167)	3-15
Controls and Functions (RT-1167C)	3-15.1
Controls, Dispenser Electronic Module	4-17
Controls, Displays and Function, SN/SDN-128	3-28
Cooler Failures, FLIR	9-49
Cooler and Filter, Oil	2-30
Cooling, Engine	2-23
Coordinate Data-Storing, Waypoint/Targeting	4-59
Copilot/Gunner (CPG) Control Panels	4-29
Copilot/Gunner Fire Control Panel	4-33
Copilot/Gunner Instrument Panel and Consoles	2-16
Copilot/Gunner Missile Control Panel	4-32
Copilot/Gunner Station Instruments	2-38
Counter, History	2-40.1
Countermeasure Set (AN/ALQ-144(V)), Infrared	4-24
Countermeasures Subsystem Control Panel (Complete Provisions Only), Radar/Infrared	4-25

ALPHABETICAL INDEX (cont)

Subject	Paragraph
Covers, Protective	2-135
CPG Battery Override Switch	2-103
CPG CBR Blower	2-20.4
CPG Caution/Warning Panels,	2-119
CPG Fuel Management Panel	2-43
CPG Master Caution and Warning Panels	2-118
Crew Briefings	8-4
Crew Duties/Responsibilities	8-3
Crew Member Seats	2-14
Crew Requirements, Minimum	5-4
Crew Station Instruments, Indicators, and Annunciators	2-11
Cruise Flight, Loss of Tail Rotor Thrust	9-23
Cruise, Dual Engine Failure Low Altitude/Low Airspeed	9-16
Cruise, Single-Engine Failure Low Altitude/Low Airspeed	9-12
Cueing	4-61
Cyclic Sticks	2-52
Cyclic and Collective Mission Equipment Switches	4-10

D

Subject	Paragraph
Damper Assemblies	2-91
Danger Areas	2-7
DASE Malfunction	9-46
Data Entry	3-35
Data Entry Keyboard (DEK)	4-34
Data Entry Keyboard Operation	4-35
Data Entry Procedures	3-38.4
Data Sensor Subsystem (ADSS), Air	4-3
Data Validation, CBHK	4-39.1
Data, Loading	6-9
Data, Performance	7-1
Data-Storing, Waypoint/Targeting Coordinate	4-59
DC Power Supply System	2-100
DD FORM 365-3, Chart C - Basic Weight and Balance Record,	6-8
DD FORM 365-4, Weight and Balance Clearance FORM F,	6-10
De-icing, Anti-Icing	2-94
Defined, Warnings, Cautions, and Notes	1-2
Definition of Emergency Terms	9-3
Definition, Symbols	8-6
Definitions, Balance	6-7
Definitions, Weight	6-6
Delivery System-Inflight Procedures, Aerial Rocket Control	4-55
Description	1-3
Description (Avionics)	3-1
Description, Armament	4-45
Designation Sight (TADS) AN/ASQ-170, Target Acquisition	4-37
Designation, Aircraft	1-11
Destruction of Army Material to Prevent Enemy Use	1-8
Detection, Engine and Auxiliary Power Unit Fire	2-19
Detection/Location System, Fault	4-38
Detector Set AN/APR-39V-1, Radar Signal	4-20
Detector, Engine Chip	2-31
Digital Automatic Stabilization Equipment	2-57
Dimensions, Principal	2-5
Dimming, Warning and Caution Segment	2-120
Direction Finder Set AN/ARN-89	3-22
Directional Control Pedals	2-54
Dispenser Electronic Module Controls	4-17
Dispenser Kit M-130	4-16
Dispenser Kit Operation	4-19
Dispenser Kit Safety Procedures	4-18
Display (AND), Alpha/Numeric	4-43
Display (HAD), High Action	4-42
Display Sight Subsystem (IHADSS), Integrated Helmet	4-7
Display Unit (VDU), Video	2-112
Display Unit, Video	4-15
Display and Keyboard Operation, Window	3-34
Displays and Function, SN/SDN-128 Controls,	3-28
Displays and Functions, AN/ASN-137 Controls	3-38.1
Displays, AN/ASN-137	3-38.3
Displays, Optical Relay Tube (ORT) Controls	4-36
Ditching (Power OFF)	9-42
Ditching (Power ON)	9-41
Ditching, Landing	9-39
DNS Antenna	3-27
Doppler Navigation Sets	3-26
Drift Null, TADS Manual	4-49.2
Drive Clutch Failure, Main Transmission Input	9-26
Drive Shafting, Tail Rotor	2-81
Drive System, Main Rotor	2-73
Drive System, Tail Rotor	2-80
Drive, Rotors, Transmissions	9-20

ALPHABETICAL INDEX (cont)

Subject Paragraph

Dual Engine Failure Low Altitude/Low Airspeed and Cruise . . . 9-16
Dual-Engine Failure: General . . . 9-15
During Flight, Engine Restart . . . 9-13
During High Winds, Ground Operations . . 8-58
Duties/Responsibilities, Crew . . . 8-3

E

Egress, Emergency . . . 9-6
Electrical Fire in Flight . . . 9-32
Electrical Power Sources . . . 2-50
Electrical Power System . . . 2-97
Electrical System Malfunctions . . . 9-34
Electronic Module Controls, Dispenser . . . 4-17
Electronic Unit (TEU) Failure, TADS . . . 9-48
Elimination, Smoke and Fume . . . 9-33
Emergency Egress . . . 9-6
Emergency Entrance . . . 9-7
Emergency Equipment . . . 2-17
Emergency Exits and Equipment . . . 9-5
Emergency Landing in Wooded Areas (Power OFF) . . . 9-40
Emergency Operation . . . 3-4
Emergency Procedures . . . 2-21
Emergency Start . . . 9-14
Emergency Steps, Immediate-Action . . . 9-2
Emergency Terms, Definition . . . 9-3
Empennage (Area 6), Right Side-Aft Fuselage . . . 8-16
Empennage (Area 7), Left Side-Aft Fuselage . . . 8-17
ENCU Malfunction . . . 9-52
Engine Air Induction . . . 2-24
Engine Alternator Malfunction . . . 9-56
Engine Bleed Air, No. 1 . . . 2-70
Engine Caution/Warning Annunciators . . . 2-39
Engine Chip Detector . . . 2-31
Engine Compressor Stall . . . 9-19
Engine Control System . . . 2-35
Engine Cooling . . . 2-23
Engine Emergency Oil System . . . 2-28
Engine Failure Low Altitude/Low Airspeed and Cruise, Dual . . . 9-16
Engine Failure: General . . . 9-10
Engine Fire in Flight . . . 9-31
Engine Fuel Control System . . . 2-26
Engine/Fuselage Fire on Ground . . . 9-28
Engine Instruments . . . 2-36
Engine Malfunctions. Partial or Complete Power Loss . . . 9-8

Subject Paragraph

Engine Nose Gearbox Caution Light Provisions . . . 2-75
Engine Nose Gearboxes . . . 2-74
Engine Oil System . . . 2-27
Engine Oil System Characteristics . . . 8-55
Engine Oil System Servicing . . . 2-128
Engine Operation . . . 8-54
Engine Overspeed Check Limitations . . . 5-15
Engine Power Limitations . . . 5-10
Engine Restart During Flight . . . 9-13
Engine Shutdown-Copilot/Gunner . . . 8-45
Engine Shutdown-Pilot . . . 8-44
Engine Start Limits . . . 5-14
Engine Starter Limitations . . . 5-12
Engine Starting System . . . 2-33
Engine Temperature Limitations . . . 5-11
Engine Warmup . . . 8-56
Engine and Auxiliary Power Unit Fire Detection . . . 2-19
Engine and Engine Inlet Anti-Icing System . . . 2-25
Engine/Fuselage Fire on Ground . . . 9-28
Engines . . . 2-22
Engines-External Pressurized Air Source-Pilot, Starting . . . 8-24
Engines-Pilot, Before Starting . . . 8-27
Engines-Pilot, Starting . . . 8-28
Entrance, Emergency . . . 9-7
Entry Keyboard (DEK) . . . 4-34
Entry Procedures, Data . . . 3-38.4
Entry, Data . . . 3-35
Entry, Waypoint/Targeting-Data . . . 4-58
Environmental Conditions, Adverse . . . 8-50
Environmental Control System . . . 2-96
Environmental Restrictions . . . 5-23
Equipment (ALSE), Aviation Life Support . . . 8-2
Equipment - CBR Blower, Survivability . . 2-20.1
Equipment Configuration, Avionics . . . 3-2
Equipment Stowage Compartments . . . 2-13
Equipment, Digital Automatic Stabilization . . . 2-57
Equipment, Emergency . . . 2-17
Equipment, Lighting . . . 2-105
Equipment, Mission . . . 6-20
Exceeding Operational Limits . . . 5-3
Exits and Equipment, Emergency . . . 9-5
Explanation of Change Symbols . . . 1-10
Extent of Coverage . . . 6-2
Exterior Check . . . 8-10
Exterior Lighting System . . . 2-106

ALPHABETICAL INDEX (cont)

Subject Paragraph

External Air Source Receptacles 2-71
External Power Receptacle 2-99
External Stores Subsystem (ESS) 4-8
Extinguisher, Portable Fire 2-18
Extra Cargo 6-29

F

Failed High, High RPM Rotor (Warning Light ON) Np 9-17
Failed Low, Low RPM Rotor (Warning Light ON) Np 9-18
Failure Low Altitude/Low Airspeed and Cruise, Dual Engine 9-16
Failure Low Altitude/Low Airspeed and Cruise, Single-Engine 9-12
Failure, Main Transmission Input Drive Clutch 9-26
Failure, Mission Equipment 9-50
Failure, PNVS 9-54
Failure, Pilot IHADSS/HDU 9-55
Failure, Stabilator Auto/Manual Mode 9-45
Failure, Stabilator Automatic Mode 9-44
Failure, Symbol Generator 9-47
Failure, TADS Electronic Unit (TEU) 9-48
Failure: General, Dual-Engine 9-15
Failure: General, Engine 9-10
Failure: General, Single-Engine 9-11
Failures, FLIR Cooler 9-49
Fault Detection/Location System 4-38
Feel, Trim 2-55
Filter, Oil Cooler 2-30
Fire Control Computer (FCC) 4-5
Fire Control Panel, Copilot/Gunner 4-33
Fire Control Panel, Pilot 4-14
Fire Control System Messages 4-41
Fire Detection, Engine and Auxiliary Power Unit 2-19
Fire Extinguisher, Portable 2-18
Fire Handle Illumination in Flight, APU 9-29
Fire in Flight, Electrical 9-32
Fire in Flight, Engine 9-31
Fire on Ground, Engine/Fuselage 9-28
Fire, APU Compartment 9-30
Fires 9-27
First Aid Kits 2-20
Fixed Pitch Malfunction, Tail Rotor 9-25
Flight Characteristics 9-9
Flight Characteristics-General 8-49
Flight Control Malfunctions 9-43
Flight Control Servos 2-56

Subject Paragraph

Flight Control System 2-51
Flight Instruments 2-108
Flight Procedures, Instrument 8-48
Flight Symbology (PNVS) 4-28
Flight, Instrument 8-47
FLIR Cooler Failures 9-49
FORM F, DD FORM 365-4, Weight and Balance Clearance 6-10
Forms and Records 1-9
Free (Outside) Air Temperature Indicator 2-115
Fuel Control System, Engine 2-26
Fuel Management Panel, CPG 2-43
Fuel Moments 6-16
Fuel Quantity Indicators 2-44
Fuel Supply, Auxiliary Power 2-58
Fuel System 2-41
Fuel System Caution/Warning Lights 2-45
Fuel System Servicing 2-126
Fuel Tank, Auxiliary 2-46
Fuel Weight and Moment 6-15
Fuselage (Area 2), Right Side-Lower Center 8-12
Fuselage (Area 5), Right Side-Rear Center 8-15
Fuselage and Nose (Area 11), Left Side-Lower Center 8-21
Fuselage, Right Side-Under Side 8-11
Fuselage/Empennage (Area 6), Right Side-Aft 8-16
Fuselage/Empennage (Area 7), Left Side-Aft 8-17

G

Gear, Landing 2-9
Gearbox Caution Light Indicators, Intermediate 2-83
Gearbox Caution Light Indicators, Tail Rotor 2-85
Gearbox Caution Light Provisions, Engine Nose 2-75
Gearbox Servicing, Nose 2-131
Gearbox, Intermediate 2-82
Gearbox, Tail Rotor 2-84
Gearboxes, Engine Nose 2-74
GEN 1 AND GEN 2 Caution Light ON 9-35
General (Personnel, Weight and Balance) 6-18
General (Aircraft) 2-1
General (Introduction) 1-1
General Arrangement 2-4
General Information, CBR Blower - 2-20.2

ALPHABETICAL INDEX (cont)

Subject Paragraph

General, Dual-Engine Failure:. 9-15
General, Engine Failure:. 9-10
General, Single-Engine Failure: 9-11
Generator, Symbol 4-9
Generators 2-101
Ground Air Source 2-133
Ground Operations During High Winds . . 8-58
Gun System - Inflight Procedures,
  M-230E1, 30mm 4-54

H

Hand Pump 2-67
Handle Illumination in Flight, APU Fire. . 9-29
HARS Self Test. 3-52.1
HDU Failure, Pilot IHADSS 9-55
Heading and Attitude Reference System
  (HARS). 3-52
Headset Audio Warning System 2-124
Helicopter Class 6-3
Helicopter Compartments and Stations. . . 6-4
Helicopter Mission Avionics 4-2
Helicopter Systems 9-1
Hellfire Launchers 6-22
Hellfire Missiles 6-23
Helmet and Display Sight Subsystem
  (IHADSS), Integrated 4-7
High Action Display (HAD). 4-42
High RPM Rotor (Warning Light ON) Np
  Failed High. 9-17
History Counter 2-40.1
History Recorder. 2-40
Horizontal Situation Indicator (HSI). 3-39
Hub Assembly. 2-88
Hydraulic Pump, Primary. 2-61
Hydraulic System Malfunctions. 9-36
Hydraulic System Servicing. 2-132
Hydraulic System, Primary. 2-60
Hydraulic System, Utility 2-64
Hydraulic Systems 2-59

I

Ignition System 2-37
IHADSS Boresight-CPG 4-50
IHADSS Boresight-Pilot 4-48
IHADSS, PNVS 9-53
IHADSS/HDU Failure, Pilot 9-55
Immediate-Action Emergency Steps 9-2
Index 1-6
Index, Chapter 7 (Performance Data) 7-2

Subject Paragraph

Indicator (HSI), Horizontal Situation 3-39
Indicator (RMI), Radio Magnetic. 2-117
Indicator, Free (Outside) Air
  Temperature. 2-115
Indicators. 2-3
Indicators (VSI), Vertical Speed 2-121
Indicators, Airspeed 2-122
Indicators, Attitude. 2-123
Indicators, Fuel Quantity 2-44
Indicators, Intermediate Gearbox Caution
  Light 2-83
Indicators, Tail Rotor Gearbox Caution
  Light 2-85
Indicators, and Annunciators, Crew
  Station Instruments,. 2-11
Inerting Unit (NIU), Nitrogen. 2-49
Inflight Procedures, M-230E1, 30mm Gun
  System - 4-54
Inflight Procedures, Point Target
  Weapons System -. 4-56
Infrared (IR) Suppression System 2-34
Infrared Countermeasure Set
  (AN/ALQ-144(V)) 4-24
Inlet Limits, Pneumatic Source. 5-13
Input Drive Clutch Failure, Main
  Transmission 9-26
Instrument Flight. 8-47
Instrument Flight Procedures. 8-48
Instrument Marking Color Code. 5-6
Instrument Markings Illustrations 5-5
Instrument Panel and Consoles,
  Copilot/Gunner. 2-16
Instrument Panel and Consoles, Pilot. . . . 2-15
Instruments, Copilot/Gunner Station 2-38
Instruments, Engine. 2-36
Instruments, Flight. 2-108
Instruments, Indicators, and
  Annunciators, Crew Station 2-11
Instruments, Pilot Station 2-37
Integrated Helmet and Display Sight
  Subsystem (IHADSS) 4-7
Intercommunication System
  C-10414(V)3/ARC - C-11746(V)4/ARC . . 3-5
Interior Check-Copilot/Gunner 8-34
Interior Check-Pilot 8-22
Interior Lighting System. 2-107
Intermediate Gearbox. 2-82
Intermediate Gearbox Caution Light
  Indicators 2-83
Introduction (Weight and Balance) 6-1

ALPHABETICAL INDEX (cont)

Subject Paragraph

J

Jettison, Wing Stores . . . 9-51

K

KY-28, Voice Security System TSEC . . . 3-21
KY-58, Voice Security System TSEC . . . 3-18
Keyboard (DEK), Data Entry . . . 4-34
Keyboard Operation, Data Entry . . . 4-35
Kit M-130, Dispenser . . . 4-16
Kit Operation, Dispenser . . . 4-19
Kit-1A/TSEC, Transponder Computer . . . 3-46
Kits, First Aid . . . 2-20

L

Landing Check, After . . . 8-43
Landing Check, Before . . . 8-41
Landing Gear . . . 2-9
Landing Gear Brakes . . . 2-10
Landing Limits . . . 5-22
Landing and Ditching . . . 9-39
Landing in Wooded Areas (Power OFF), Emergency . . . 9-40
Landing, Slope/Rough Terrain . . . 8-42
Launchers, Hellfire . . . 6-22
Launchers, Rocket . . . 6-24
Lead-Lag Links . . . 2-90
Level Acceleration/Obstacle Clearance Takeoff . . . 8-39
Life Support Equipment (ALSE) . . . 8-2
Lighting Equipment . . . 2-105
Lighting System, Exterior . . . 2-106
Lighting System, Interior . . . 2-107
Lightning Strikes . . . 8-57
Lights, Fuel System Caution/Warning . . . 2-45
Lights, Main Transmission Caution . . . 2-78
Limitations, Engine Overspeed Check . . . 5-15
Limitations, Engine Power . . . 5-10
Limitations, Engine Starter . . . 5-12
Limitations, Engine Temperature . . . 5-11
Limitations, Rotor . . . 5-7
Limitations, Rotor Speed . . . 5-9
Limitations, Weight . . . 5-18
Limits Chart, Airspeed Operating . . . 5-20
Limits Chart, Center of Gravity . . . 6-31
Limits, Airspeed Operating . . . 5-19
Limits, Auxiliary Power Unit (APU) Operating . . . 5-16
Limits, Center of Gravity . . . 5-17
Limits, Engine Start . . . 5-14
Limits, Exceeding Operational . . . 5-3
Limits, Landing . . . 5-22
Limits, Maneuvering . . . 5-21
Limits, Pneumatic Source Inlet . . . 5-13
Limits, Rotor Start and Stop . . . 5-8
Links, Lead-Lag . . . 2-90
Loading Data . . . 6-9
Loading, Cargo . . . 6-28
Loss of Tail Rotor Thrust at Low Airspeed/Hover . . . 9-24
Loss of Tail Rotor Thrust in Cruise Flight . . . 9-23
Loss of Tail Rotor Thrust-General . . . 9-22
Lubrication, Main Transmission . . . 2-77

M

M-130, Dispenser Kit . . . 4-16
M-230E1, 30mm Gun System - Inflight Procedures . . . 4-54
Magnetic Compass, Standby . . . 2-114
Magnetic Indicator (RMI), Radio . . . 2-117
Main Rotor Blades . . . 2-92
Main Rotor Drive System . . . 2-73
Main Rotor System . . . 2-87
Main Transmission . . . 2-76
Main Transmission Caution Lights . . . 2-78
Main Transmission Input Drive Clutch Failure . . . 9-26
Main Transmission Lubrication . . . 2-77
Main Transmission Servicing . . . 2-129
Malfunction, DASE . . . 9-46
Malfunction, ENCU . . . 9-52
Malfunction, Engine Alternator . . . 9-56
Malfunction, Tail Rotor Fixed Pitch . . . 9-25
Malfunctions, Electrical System . . . 9-34
Malfunctions, Flight Control . . . 9-43
Malfunctions, Hydraulic System . . . 9-36
Malfunctions, Tail Rotor . . . 9-21
Management Panel, CPG Fuel . . . 2-43
Maneuvering Limits . . . 5-21
Manifold, Primary . . . 2-62
Manifold, Utility . . . 2-65
Manual Drift Null, TADS . . . 4-49.2
Master Caution and Warning Panels, Pilot and CPG . . . 2-118
Maximum Performance . . . 8-38
Messages, Fire Control System . . . 4-41
Minimum Crew Requirements . . . 5-4
Missile Control Panel, Copilot/Gunner . . . 4-32

ALPHABETICAL INDEX (cont)

Subject . . . Paragraph

Missile Control Panel, Pilot . . . 4-13
Missiles, Hellfire . . . 6-23
Mission Avionics, Helicopter . . . 4-2
Mission Avionics-General . . . 4-1
Mission Equipment . . . 6-20
Mission Equipment Failure . . . 9-50
Mission Planning . . . 8-1
Modes of Operation (C-10414(V)3/ARC) . . . 3-7
Modes of Operation (AN/ARC-186(V)) . . . 3-11
Modes of Operation (RT-1167 C) . . . 3-16
Modes of Operation (AN/ASN-128) . . . 3-29
Modes of Operation, AN/ASN-137 . . . 3-38.2
Moments, Fuel . . . 6-16
Moments, Oil . . . 6-14
Moments, Personnel . . . 6-19
Mooring . . . 2-138
Multiplex Bus Subsystem (MUX) . . . 4-6

N

Navigation Sets, Doppler . . . 3-26
Night Vision Sensor (PNVS) (AN/AAQ-11), Pilot . . . 4-27
Nitrogen Inerting Unit (NIU) . . . 2-49
No. 1 Engine Bleed Air . . . 2-70
Normal Operation (IFF) . . . 3-45
Nose Gearbox Servicing . . . 2-131
Notes Defined, Warnings, Cautions, and . . . 1-2
Np Failed High, High RPM Rotor (Warning Light ON) . . . 9-17
Np Failed Low, Low RPM Rotor (Warning Light ON) . . . 9-18

O

Obstacle Clearance Takeoff, Level Acceleration . . . 8-39
Oil Cooler and Filter . . . 2-30
Oil Moments . . . 6-14
Oil Tank . . . 2-29
Operating Limits, Airspeed . . . 5-19
Operating Limits, Auxiliary Power Unit (APU) . . . 5-16
Operating Procedure (AN/APR-39V-1) . . . 4-23
Operating Procedures . . . 3-37
Operating Procedures . . . 3-38.6
Operating Procedures and Maneuvers . . . 8-5
Operating Procedures, Radio Set AN/ARC-186 . . . 3-12
Operation (AN/APN-209(V)) . . . 3-50
Operation (AN/ARN-89) . . . 3-25

Subject . . . Paragraph

Operation (IFF) . . . 3-44
Operation (VRS) . . . 4-31
Operation (AN/APR-39V-1) . . . 4-21
Operation (IFF), Normal . . . 3-45
Operation (KY-58) . . . 3-20
Operation, AN/ASN-137 Modes of . . . 3-38.2
Operation, Data Entry Keyboard . . . 4-35
Operation, Dispenser Kit . . . 4-19
Operation, Emergency . . . 3-4
Operation, Engine . . . 8-54
Operation, Modes of (C-10414(V)3/ARC) . . . 3-7
Operation, Modes of (AN/ARC-186(V)) . . . 3-11
Operation, Modes of (RT-1167 C) . . . 3-16
Operation, Modes of (AN/ASN-128) . . . 3-29
Operational Checks-CPG, TADS . . . 4-49
Operational Procedures Radio Set AN/ARC-164 . . . 3-17
Operations, Cold Weather . . . 8-51
Optical Relay Tube (ORT) Controls and Displays . . . 4-36
Override Switch, CPG Battery . . . 2-103

P

Panel (ARCS), Aerial Rocket Control Subsystem . . . 4-12
Panel and Consoles, Copilot/Gunner Instrument . . . 2-16
Panel and Consoles, Pilot Instrument . . . 2-15
Panel, CPG Fuel Management . . . 2-43
Panel, Copilot/Gunner Fire Control . . . 4-33
Panel, Copilot/Gunner Missile Control . . . 4-32
Panel, Pilot Fire Control . . . 4-14
Panel, Pilot Fuel Control (Management) . . . 2-42
Panel, Pilot Missile Control . . . 4-13
Panels, Copilot/Gunner (CPG) Control . . . 4-29
Panels, Pilot Control . . . 4-11
Panels, Pilot and CPG Caution/Warning . . . 2-119
Panels, Pilot and CPG Master Caution and Warning . . . 2-118
Panels, Windshield and Canopy . . . 2-12
Partial or Complete Power Loss , Engine Malfunctions . . . 9-8
Pechan Realignment, TADS . . . 4-49.1
Pedals, Directional Control . . . 2-54
Performance Data . . . 7-1
Performance, Maximum . . . 8-38
Pilot CBR Blower . . . 2-20.3
Pilot Control Panels . . . 4-11
Pilot Fire Control Panel . . . 4-14
Pilot Fuel Control (Management) Panel . . . 2-42

ALPHABETICAL INDEX (cont)

Subject . . . Paragraph

Pilot IHADSS/HDU Failure . . . 9-55
Pilot Instrument Panel and Consoles . . . 2-15
Pilot Missile Control Panel . . . 4-13
Pilot Night Vision Sensor (PNVS) (AN/AAQ-11) . . . 4-27
Pilot Station Instruments . . . 2-37
Pilot and CPG Caution/Warning Panels . . . 2-119
Pilot and CPG Master Caution and Warning Panels . . . 2-118
Pitch Housing . . . 2-89
Pitot-Static System . . . 2-109
Pneumatic Source Inlet Limits . . . 5-13
PNVS Failure . . . 9-54
PNVS/IHADSS . . . 9-53
Point Target Weapons System - Inflight Procedures . . . 4-56
Portable Fire Extinguisher . . . 2-18
Position Update . . . 4-60
Power Supply System, AC . . . 2-98
Power Supply System, DC . . . 2-100
Power Supply, Avionics . . . 3-3
Power Train . . . 2-72
Power Up Procedures (AN/ASN-137) . . . 3-38.5
Preflight Check . . . 8-8
Preflight Procedures . . . 4-46
Preflight, Cold Weather . . . 8-52
Pressurized Air System . . . 2-68
Primary Hydraulic Pump . . . 2-61
Primary Hydraulic System . . . 2-60
Primary Manifold . . . 2-62
Principal Dimensions . . . 2-5
PRI HYD PSI and UTIL HYD PSI Light On . . . 9-37
PRI HYD PSI and OIL UTIL HYD Light On . . . 9-38
Procedure (AN/APR-39V-1), Operating . . . 4-23
Procedure, Starting (AN/APN-137) . . . 3-36
Procedure, Stopping (AN/ASN-128) . . . 3-38
Procedure, Stopping (AN/ASN-137) . . . 3-38.7
Procedure, Stopping (AN/APN-209) . . . 3-51
Procedures (AN/APR-39V-1), Self-Test . . . 4-22
Procedures Radio Set AN/ARC-164, Operational . . . 3-17
Procedures, Aerial Rocket Control and Delivery System-Inflight . . . 4-55
Procedures, Data Entry . . . 3-38.4
Procedures, Dispenser Kit Safety . . . 4-18
Procedures, Emergency . . . 2-21
Procedures, Instrument Flight . . . 8-48

Subject . . . Paragraph

Procedures, M-230E1, 30mm Gun System - Inflight . . . 4-54
Procedures, Operating . . . 3-37
Procedures, Operating . . . 3-38.6
Procedures, Point Target Weapons System - Inflight . . . 4-56
Procedures, Power Up . . . 3-38.5
Procedures, Preflight . . . 4-46
Procedures, Waypoint/Targeting . . . 4-57
Protective Covers . . . 2-135
Pump, Hand . . . 2-67
Pump, Primary Hydraulic . . . 2-61
Purpose (Operating Limits) . . . 5-1
Pylons . . . 6-21

Q

Quantity Indicators, Fuel . . . 2-44

R

Radar Jammer Set AN/ALQ-136 (Complete Provisions Only) . . . 4-26
Radar Signal Detector Set AN/APR-39V-1. 4-20
Radar/Infrared Countermeasures Subsystem Control Panel (Complete Provisions Only) . . . 4-25
Radio Magnetic Indicator (RMI) . . . 2-117
Radio Set AN/ARC-164, Operational Procedures . . . 3-17
Radio Set AN/ARC-186(V) . . . 3-8
Radio Set AN/ARC-186, Operating Procedures, . . . 3-12
Radio, RT-1167C/ARC-164(V), Receiver-Transmitter . . . 3-13
Rain Removal . . . 2-95
Rapid Rearming . . . 4-52
Rapid Refueling . . . 2-127
Right Side-Aft Fuselage/Empennage (Area 6) . . . 8-16
Right Side-Lower Center Fuselage (Area 2) . . . 8-12
Right Side-Mast (Area 3) . . . 8-13
Right Side-Rear Center Fuselage (Area 5). 8-15
Right Side-Under Side Fuselage . . . 8-11
Right Side-Wing (Area 4) . . . 8-14
Rocket Launchers . . . 6-24
Rockets (2.75-inch) . . . 6-25
Rotor Blades, Main . . . 2-92

ALPHABETICAL INDEX (cont)

Subject Paragraph

Rotor Brake 2-79
Rotor Limitations 5-7
Rotor Speed Limitations 5-9
Rotor Start and Stop Limits 5-8
Rotor System 2-86
Rotors, Transmission, and Drive Systems . 9-20
RT-1167C/ARC-164(V), Receiver-
  Transmitter Radio, ... 3-13

S

Safety Program, Army Aviation 1-7
Seats, Crew Member 2-14
Security System TSEC/KY-28, Voice 3-21
Security System TSEC/KY-58, Voice 3-18
Self Test, HARS 3-52.1
Self-Test Procedures (AN/APR-39V-1) 4-22
Sensor (PNVS) (AN/AAQ-11), Pilot Night
  Vision 4-27
Servicing 2-125
Servicing, Auxiliary Power Unit (APU) ... 2-130
Servicing, Engine Oil System 2-128
Servicing, Fuel System 2-126
Servicing, Hydraulic System 2-132
Servicing, Main Transmission 2-129
Servicing, Nose Gearbox 2-131
Servos, Flight Control 2-56
Set (AN/ALQ-144(V)), Infrared
  Countermeasure 4-24
Sight (TADS) AN/ASQ-170, Target
  Acquisition Designation 4-37
Single-Engine Failure Low Altitude/Low
  Airspeed and Cruise 9-12
Single-Engine Failure: General 9-11
Slope/Rough Terrain Landing 8-42
Smoke and Fume Elimination 9-33
SN/SDN-128 Controls, Displays and
  Function 3-28
Sources, Electrical Power 2-50
Speed Limitations, Rotor 5-9
Stabilator Auto/Manual Mode Failure 9-45
Stabilator Automatic Mode Failure 9-44
Stabilator Operation 8-40
Stabilator System 2-58
Standby Magnetic Compass 2-114
Start Limits, Engine 5-14
Start and Stop Limits, Rotor 5-8
Start, Emergency 9-14
Starter Limitations, Engine 5-12
Starting APU-Pilot 8-25

Subject Paragraph

Starting Engines-External Pressurized Air
  Source-Pilot 8-24
Starting Engines-Pilot 8-28
Starting Procedure (AN/ASN-137) 3-36
Starting System, Engine 2-33
Stations, Helicopter Compartments 6-4
Sticks, Collective 2-53
Sticks, Cyclic 2-52
Stopping Procedure (AN/ASN-128) 3-38
Stopping Procedure (AN/ASN-137) 3-38.7
Stopping Procedure (AN/APN-209) 3-51
Stores Configuration, Wing 5-24
Stores Jettison, Wing 9-51
Stowage Compartments, Equipment 2-13
Strikes, Lightning 8-57
Subsystem (MUX), Multiplex Bus 4-6
Subsystem (VRS), Video Recorder 4-30
Suppression System, Infrared (IR) 2-34
Supply System, AC Power 2-98
Supply System, DC Power 2-100
Supply, Auxiliary Power Fuel 2-58
Supply, Avionics Power 3-3
Survivability Equipment - CBR Blower ... 2-20.1
Switch, CPG Battery Override 2-103
Switches, Cyclic and Collective Mission
  Equipment 4-10
Symbol Generator 4-9
Symbol Generator Failure 9-47
Symbology, Weapons 4-40
Symbols Definition 8-6
Symbols, Explanation of Change 1-10
System Caution/Warning Lights, Fuel 2-45
System Characteristics, Engine Oil 8-55
System Malfunctions, Electrical 9-34
System Malfunctions, Hydraulic 9-36
System Messages, Fire Control 4-41
System Servicing, Engine Oil 2-128
System Servicing, Fuel 2-126
System Servicing, Hydraulic 2-132
System TSEC/KY-28, Voice Security 3-21
System TSEC/KY-58, Voice Security 3-18
System, AC Power Supply 2-98
System, DC Power Supply 2-100
System, Electrical Power 2-97
System, Engine Control 2-35
System, Engine Emergency Oil 2-28
System, Engine Fuel Control 2-26
System, Engine Oil 2-27
System, Engine Starting 2-33
System, Engine and Engine Inlet
  Anti-Icing 2-25

ALPHABETICAL INDEX (cont)

Subject	Paragraph
System, Environmental Control	2-96
System, Exterior Lighting	2-106
System, Fault Detection/Location	4-38
System, Flight Control	2-51
System, Fuel	2-41
System, Headset Audio Warning	2-124
System, Ignition	2-37
System, Infrared (IR) Suppression	2-34
System, Interior Lighting	2-107
System, Main Rotor	2-87
System, Main Rotor Drive	2-73
System, Pitot-Static	2-109
System, Pressurized Air	2-68
System, Primary Hydraulic	2-60
System, Rotor	2-86
System, Stabilator	2-58
System, Tail Rotor Drive	2-80
System, Utility Hydraulic	2-64
System-Inflight Procedures, Aerial Rocket Control and Delivery	4-55
Systems, Helicopter	9-1
Systems, Hydraulic	2-59

T

Subject	Paragraph
TADS Boresight	4-51
TADS Electronic Unit (TEU) Failure	9-48
TADS Manual Drift Null	4-49.2
TADS Operational Checks-CPG	4-49
TADS Pechan Realignment	4-49.1
Tail Rotor	2-93
Tail Rotor Drive Shafting	2-81
Tail Rotor Drive System	2-80
Tail Rotor Fixed Pitch Malfunction	9-25
Tail Rotor Gearbox	2-84
Tail Rotor Gearbox Caution Light Indicators	2-85
Tail Rotor Malfunctions	9-21
Takeoff Check, Before	8-33
Takeoff, Level Acceleration/Obstacle Clearance	8-39
Tank, Auxiliary Fuel	2-46
Tank, Oil	2-29
Target Acquisition Designation Sight (TADS) AN/ASQ-170	4-37
Targeting Procedures, Waypoint	4-57
Targeting-Data Entry, Waypoint	4-58
Taxi	8-37
Taxi Check	8-31
Temperature Indicator, Free (Outside) Air	2-115
Temperature Limitations, Engine	5-11
Terrain Landing, Slope/Rough	8-42
Test Mode	3-30
Test, HARS Self	3-52.1
Tests, On Command	4-39
Towing the Helicopter	2-137
Transmission Lubrication, Main	2-77
Transmission Servicing, Main	2-129
Transmission, Main	2-76
Transponder AN/APX-100(V)1(IFF)	3-41
Transponder Computer Kit-1A/TSEC	3-46
Trim Feel	2-55
TSEC, Transponder Computer Kit-1A	3-46
TSEC/KY-28, Voice Security System	3-21
TSEC/KY-58, Voice Security System	3-18
Turbulence	5-18.1
Turbulence Operation	8-59
Turning Radius and Ground Clearance	2-6

U

Subject	Paragraph
Utility Accumulator	2-66
Utility Hydraulic System	2-64
Utility Manifold	2-65

V

Subject	Paragraph
Validation, CBHK Data	4-39.1
Values, Alteration of CBHK	5-25
Vertical Speed Indicators (VSI)	2-121
Video Display Unit	4-15
Video Display Unit (VDU)	2-112
Video Recorder Subsystem (VRS)	4-30
Voice Security System TSEC/KY-28	3-21
Voice Security System TSEC/KY-58	3-18

W

Subject	Paragraph
Warning Annunciators, Engine Caution	2-39
Warning Lights, Fuel System Caution	2-45
Warning Panels, Pilot and CPG Caution	2-119
Warning Panels, Pilot and CPG Master Caution and	2-118
Warning System, Headset Audio	2-124
Warning and Caution Segment Dimming	2-120
Waypoint/Targeting Coordinate Data-Storing	4-59
Waypoint/Targeting Procedures	4-57
Waypoint/Targeting-Data Entry	4-58
Weapons Symbology	4-40

ALPHABETICAL INDEX (cont)

Subject Paragraph

Weapons System - Inflight Procedures, Point Target 4-56
Weather Operations, Cold. 8-51
Weather Preflight, Cold 8-52
Weight Definitions 6-6
Weight Limitations 5-18
Weight and Balance 6-5
Weight and Balance Clearance FORM F, DD FORM 365-4. 6-10
Weight and Balance Record, DD FORM 365-3, Chart C - Basic. 6-8
Weight and Moment, Fuel. 6-15
Window Display and Keyboard Operation . 3-34
Windshield and Canopy Panels 2-12
Wing Auxiliary Fuel and Tanks. 6-17
Wing Stores Configuration 5-24
Wing Stores Jettison. 9-51
Wire Strike Protection System (WSPS) . . . 2-20.5

Subject Paragraph

X

Y

Z

By Order of the Secretary of the Army:

JOHN A. WICKHAM, JR.
General, United States Army
Chief of Staff

Official:

ROBERT M. JOYCE
Major General, United States Army
The Adjutant General

DISTRIBUTION:
To be distributed in accordance with DA Form 12-31, Operator Maintenance Requirements for AH-64A aircraft.

☆ U.S. GOVERNMENT PRINTING OFFICE: 1990 - 262-842 - 421/25127

RECOMMENDED CHANGES TO EQUIPMENT TECHNICAL PUBLICATIONS

THEN. . JOT DOWN THE DOPE ABOUT IT ON THIS FORM, CAREFULLY TEAR IT OUT, FOLD IT AND DROP IT IN THE MAIL!

SOMETHING WRONG WITH THIS PUBLICATION?

FROM: (PRINT YOUR UNIT'S COMPLETE ADDRESS)
PFC JOHN DOE
COA, 3d ENGINEER BN
FT. LEONARDWOOD, MO 63108

DATE SENT

PUBLICATION NUMBER	PUBLICATION DATE	PUBLICATION TITLE
TM 55-1520-238-10	28 Jun 84	Operator's Manual Army AH-64A Helicopter

BE EXACT. . PIN-POINT WHERE IT IS

PAGE NO	PARA-GRAPH	FIGURE NO	TABLE NO	IN THIS SPACE TELL WHAT IS WRONG AND WHAT SHOULD BE DONE ABOUT IT:
6	2-1a			In line 6 of paragraph 2-1a the manual states the engine has 6 Cylinders. The engine on my set only has 4 Cylinders. Change the manual to show 4 Cylinders.
81		4-3		Callout 16 on figure 4-3 is pointing at a bolt. In key to figure 4-3, item 16 is called a shim - Please correct one or the Other.
125	line 20			I ordered a gasket, item 19 on figure B-16 by NSN 2910-00-762-3001. I got a gasket but it doesn't fit. Supply says I got What I ordered, so the NSN is Wrong. Please give me a good NSN

PRINTED NAME, GRADE OR TITLE, AND TELEPHONE NUMBER
JOHN DOE, PFC (268) 317-7111

SIGN HERE John Doe
JOHN DOE

TEAR ALONG PERFORATED LINE

DA FORM 1 JUL 79 2028-2

PREVIOUS EDITIONS ARE OBSOLETE.

DRSTS-M Overprint 1, 1 Nov 80

P.S.--IF YOUR OUTFIT WANTS TO KNOW ABOUT YOUR RECOMMENDATION MAKE A CARBON COPY OF THIS AND GIVE IT TO YOUR HEADQUARTERS

TEAR ALONG PERFORATED LINE

FILL IN YOUR
UNIT'S ADDRESS

FOLD BACK

DEPARTMENT OF THE ARMY

____
____

COMMANDER
U S ARMY AVIATION SYSTEMS COMMAND
ATTN: DRSAV-MPSD
4300 GOODFELLOW BOULEVARD
ST. LOUIS, MO 63120

TEAR ALONG PERFORATED LINE

RECOMMENDED CHANGES TO EQUIPMENT TECHNICAL PUBLICATIONS

THEN. . JOT DOWN THE DOPE ABOUT IT ON THIS FORM, CAREFULLY TEAR IT OUT, FOLD IT AND DROP IT IN THE MAIL!

SOMETHING WRONG WITH THIS PUBLICATION?

FROM: (PRINT YOUR UNIT'S COMPLETE ADDRESS)

DATE SENT

PUBLICATION NUMBER	PUBLICATION DATE	PUBLICATION TITLE
TM 55-1520-238-10	28 Jun 84	Operator's Manual Army AH-64A Helicopter

BE EXACT. PIN-POINT WHERE IT IS

PAGE NO	PARA-GRAPH	FIGURE NO	TABLE NO	IN THIS SPACE TELL WHAT IS WRONG AND WHAT SHOULD BE DONE ABOUT IT:

PRINTED NAME, GRADE OR TITLE, AND TELEPHONE NUMBER

SIGN HERE

DA FORM 1 JUL 79 **2028-2**

PREVIOUS EDITIONS ARE OBSOLETE.

DRSTS-M Overprint 2, 1 Nov 80.

PS--IF YOUR OUTFIT WANTS TO KNOW ABOUT YOUR RECOMMENDATION MAKE A CARBON COPY OF THIS AND GIVE IT TO YOUR HEADQUARTERS

REVERSE OF DA FORM 2028-2 Reverse of DRSTS-M Overprint 2,
1 Nov 80

TEAR ALONG PERFORATED LINE

FILL IN YOUR
UNIT'S ADDRESS

FOLD BACK

DEPARTMENT OF THE ARMY

____

____

COMMANDER
U S ARMY AVIATION SYSTEMS COMMAND
ATTN: DRSAV-MPSD
4300 GOODFELLOW BOULEVARD
ST. LOUIS, MO 63120

TEAR ALONG PERFORATED LINE

RECOMMENDED CHANGES TO EQUIPMENT TECHNICAL PUBLICATIONS

SOMETHING WRONG WITH THIS PUBLICATION?

THEN. . JOT DOWN THE DOPE ABOUT IT ON THIS FORM. CAREFULLY TEAR IT OUT. FOLD IT AND DROP IT IN THE MAIL!

FROM (PRINT YOUR UNIT'S COMPLETE ADDRESS)

DATE SENT

PUBLICATION NUMBER	PUBLICATION DATE	PUBLICATION TITLE
TM 55-1520-238-10	28 Jun 84	Operator's Manual Army AH-64A Helicopter

BE EXACT PIN-POINT WHERE IT IS

PAGE NO	PARA-GRAPH	FIGURE NO	TABLE NO

IN THIS SPACE TELL WHAT IS WRONG AND WHAT SHOULD BE DONE ABOUT IT:

PRINTED NAME, GRADE OR TITLE, AND TELEPHONE NUMBER

SIGN HERE

DA FORM 1 JUL 79 2028-2

PREVIOUS EDITIONS ARE OBSOLETE.

DRSTS-M Overprint 2, 1 Nov 80.

P.S.--IF YOUR OUTFIT WANTS TO KNOW ABOUT YOUR RECOMMENDATION MAKE A CARBON COPY OF THIS AND GIVE IT TO YOUR HEADQUARTERS

REVERSE OF DA FORM 2028-2 Reverse of DRSTS-M Overprint 2,
1 Nov 80

TEAR ALONG

RATED LINE

FILL IN YOUR
UNIT'S ADDRESS

FOLD BACK

DEPARTMENT OF THE ARMY

____

____

COMMANDER
U S ARMY AVIATION SYSTEMS COMMAND
ATTN: DRSAV-MPSD
4300 GOODFELLOW BOULEVARD
ST. LOUIS, MO 63120

TEAR ALONG PERFORATED LINE

RECOMMENDED CHANGES TO EQUIPMENT TECHNICAL PUBLICATIONS

THEN. . JOT DOWN THE DOPE ABOUT IT ON THIS FORM, CAREFULLY TEAR IT OUT, FOLD IT AND DROP IT IN THE MAIL'

SOMETHING WRONG WITH THIS PUBLICATION?

FROM (PRINT YOUR UNIT'S COMPLETE ADDRESS)

DATE SENT

PUBLICATION NUMBER	PUBLICATION DATE	PUBLICATION TITLE
TM 55-1520-238-10	28 Jun 84	Operator's Manual Army AH-64A Helicopter

BE EXACT PIN-POINT WHERE IT IS				IN THIS SPACE TELL WHAT IS WRONG AND WHAT SHOULD BE DONE ABOUT IT:
PAGE NO	PARA-GRAPH	FIGURE NO	TABLE NO	

PRINTED NAME, GRADE OR TITLE, AND TELEPHONE NUMBER	SIGN HERE

DA FORM 1 JUL 79 **2028-2**

PREVIOUS EDITIONS ARE OBSOLETE.

DRSTS-M Overprint 2, 1 Nov 80.

P.S.--IF YOUR OUTFIT WANTS TO KNOW ABOUT YOUR RECOMMENDATION MAKE A CARBON COPY OF THIS AND GIVE IT TO YOUR HEADQUARTERS

REVERSE OF DA FORM 2028-2 Reverse of DRSTS-M Overprint 2,
1 Nov 80

TEAR ALONG ...FORATED LINE

FILL IN YOUR
UNIT'S ADDRESS

FOLD BACK

DEPARTMENT OF THE ARMY

____

____

OFFICIAL BUSINESS

COMMANDER
U S ARMY AVIATION SYSTEMS COMMAND
ATTN: DRSAV-MPSD
4300 GOODFELLOW BOULEVARD
ST. LOUIS, MO 63120

RECOMMENDED CHANGES TO EQUIPMENT TECHNICAL PUBLICATIONS

THEN. . JOT DOWN THE DOPE ABOUT IT ON THIS FORM, CAREFULLY TEAR IT OUT, FOLD IT AND DROP IT IN THE MAIL!

SOMETHING WRONG WITH THIS PUBLICATION?

FROM: (PRINT YOUR UNIT'S COMPLETE ADDRESS)

DATE SENT

PUBLICATION NUMBER TM 55-1520-238-10	PUBLICATION DATE 28 Jun 84	PUBLICATION TITLE Operator's Manual Army AH-64A Helicopter

BE EXACT. PIN-POINT WHERE IT IS

PAGE NO	PARA-GRAPH	FIGURE NO	TABLE NO

IN THIS SPACE TELL WHAT IS WRONG AND WHAT SHOULD BE DONE ABOUT IT:

PRINTED NAME, GRADE OR TITLE, AND TELEPHONE NUMBER	SIGN HERE

TEAR ALONG PERFORATED LINE

DA FORM 1 JUL 79 2028-2

PREVIOUS EDITIONS ARE OBSOLETE.

DRSTS-M Overprint 2, 1 Nov 80.

P.S.--IF YOUR OUTFIT WANTS TO KNOW ABOUT YOUR RECOMMENDATION MAKE A CARBON COPY OF THIS AND GIVE IT TO YOUR HEADQUARTERS

REVERSE OF DA FORM 2028-2 Reverse of DRSTS-M Overprint 2,
1 Nov 80

FILL IN YOUR
UNIT'S ADDRESS

FOLD BACK

TEAR ALONG ..RFORATED LINE

DEPARTMENT OF THE ARMY

____

____

COMMANDER
U S ARMY AVIATION SYSTEMS COMMAND
ATTN: DRSAV-MPSD
4300 GOODFELLOW BOULEVARD
ST. LOUIS, MO 63120

TEAR ALONG PERFORATED LINE

RECOMMENDED CHANGES TO EQUIPMENT TECHNICAL PUBLICATIONS

THEN. . JOT DOWN THE DOPE ABOUT IT ON THIS FORM. CAREFULLY TEAR IT OUT. FOLD IT AND DROP IT IN THE MAIL!

SOMETHING WRONG WITH THIS PUBLICATION?

FROM: (PRINT YOUR UNIT'S COMPLETE ADDRESS)

DATE SENT

PUBLICATION NUMBER TM 55-1520-238-10	PUBLICATION DATE 28 Jun 84	PUBLICATION TITLE Operator's Manual Army AH-64A Helicopter

BE EXACT PIN-POINT WHERE IT IS				IN THIS SPACE TELL WHAT IS WRONG AND WHAT SHOULD BE DONE ABOUT IT:
PAGE NO	PARA-GRAPH	FIGURE NO	TABLE NO	

PRINTED NAME, GRADE OR TITLE, AND TELEPHONE NUMBER	SIGN HERE

DA FORM 1 JUL 79 2028-2

PREVIOUS EDITIONS ARE OBSOLETE.

DRSTS-M Overprint 2, 1 Nov 80.

P S --IF YOUR OUTFIT WANTS TO KNOW ABOUT YOUR RECOMMENDATION MAKE A CARBON COPY OF THIS AND GIVE IT TO YOUR HEADQUARTERS

REVERSE OF DA FORM 2028-2 Reverse of DRSTS-M Overprint 2,
1 Nov 80

TEAR ALONG
RATED LINE

FILL IN YOUR
UNIT'S ADDRESS

FOLD BACK

DEPARTMENT OF THE ARMY

____

____

COMMANDER
U S ARMY AVIATION SYSTEMS COMMAND
ATTN: DRSAV-MPSD
4300 GOODFELLOW BOULEVARD
ST. LOUIS, MO 63120

The Metric System and Equivalents

Linear Measure

1 centimeter = 10 millimeters = .39 inch
1 decimeter = 10 centimeters = 3.94 inches
1 meter = 10 decimeters = 39.37 inches
1 dekameter = 10 meters = 32.8 feet
1 hectometer = 10 dekameters = 328.08 feet
1 kilometer = 10 hectometers = 3,280.8 feet

Weights

1 centigram = 10 milligrams = .15 grain
1 decigram = 10 centigrams = 1.54 grains
1 gram = 10 decigram = .035 ounce
1 dekagram = 10 grams = .35 ounce
1 hectogram = 10 dekagrams = 3.52 ounces
1 kilogram = 10 hectograms = 2.2 pounds
1 quintal = 100 kilograms = 220.46 pounds
1 metric ton = 10 quintals = 1.1 short tons

Liquid Measure

1 centiliter = 10 milliters = .34 fl. ounce
1 deciliter = 10 centiliters = 3.38 fl. ounces
1 liter = 10 deciliters = 33.81 fl. ounces
1 dekaliter = 10 liters = 2.64 gallons
1 hectoliter = 10 dekaliters = 26.42 gallons
1 kiloliter = 10 hectoliters = 264.18 gallons

Square Measure

1 sq. centimeter = 100 sq. millimeters = .155 sq. inch
1 sq. decimeter = 100 sq. centimeters = 15.5 sq. inches
1 sq. meter (centare) = 100 sq. decimeters = 10.76 sq. feet
1 sq. dekameter (are) = 100 sq. meters = 1,076.4 sq. feet
1 sq. hectometer (hectare) = 100 sq. dekameters = 2.47 acres
1 sq. kilometer = 100 sq. hectometers = .386 sq. mile

Cubic Measure

1 cu. centimeter = 1000 cu. millimeters = .06 cu. inch
1 cu. decimeter = 1000 cu. centimeters = 61.02 cu. inches
1 cu. meter = 1000 cu. decimeters = 35.31 cu. feet

Approximate Conversion Factors

To change	*To*	*Multiply by*	*To change*	*To*	*Multiply by*
inches	centimeters	2.540	ounce-inches	newton-meters	.007062
feet	meters	.305	centimeters	inches	.394
yards	meters	.914	meters	feet	3.280
miles	kilometers	1.609	meters	yards	1.094
square inches	square centimeters	6.451	kilometers	miles	.621
square feet	square meters	.093	square centimeters	square inches	.155
square yards	square meters	.836	square meters	square feet	10.764
square miles	square kilometers	2.590	square meters	square yards	1.196
acres	square hectometers	.405	square kilometers	square miles	.386
cubic feet	cubic meters	.028	square hectometers	acres	2.471
cubic yards	cubic meters	.765	cubic meters	cubic feet	35.315
fluid ounces	milliliters	29,573	cubic meters	cubic yards	1.308
pints	liters	.473	milliliters	fluid ounces	.034
quarts	liters	.946	liters	pints	2.113
gallons	liters	3.785	liters	quarts	1.057
ounces	grams	28.349	liters	gallons	.264
pounds	kilograms	.454	grams	ounces	.035
short tons	metric tons	.907	kilograms	pounds	2.205
pound-feet	newton-meters	1.356	metric tons	short tons	1.102
pound-inches	newton-meters	.11296			

Temperature (Exact)

°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C